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ECONOMIC FOUNDATIONS OF A NEW WORLD ORDER

THREE reports of wide importance have appeared almost simultaneously: on "Reconstruction", by the Federation of British Industries; on "Post-war Industrial Reconstruction", by the Association of British Chambers of Commerce; and on the "General Principles of a Post-war Economy", from the London Chamber of Commerce; with these should also be read a report entitled "Relations with Britain", based on the findings of a committee of editors of the American periodicals *Time*, *Life* and *Fortune*. The interest which American opinion is taking in post-war reconstruction is reflected in the speeches of her leaders such as Mr. Milo Perkins, of the American Board of Economic Warfare, Mr. Henry Wallace, the Vice-President, Mr. Cordell Hull and Mr. Winant. In Great Britain, Mr. Eden, Mr. Lyttelton, Sir Stafford Cripps and Mr. Herbert Morrison have not lagged behind their American colleagues either in sincerity or in boldness in expression of peace aims.

In broad outlook the three British reports are indeed encouraging. They call for a new outlook. "Quite clearly", says the Federation of British Industries, "we are on the threshold of a new world and the theories and practices of the past cannot be taken for granted in the future. . . . A new situation will have arisen and it will be necessary for industry to suit its methods to that new situation, and not merely to aim at re-creating the pre-war conditions. This does not mean that there should be a complete break with the past, but that changed conditions will, in some respects, need new methods and a positive policy to create them. Such methods will require a fresh outlook, a mutual readiness to face sacrifices, and the determination on the part of all to develop their maximum effort." The actual proposals of the reports, however, betray a spirit quite inconsistent with the courage and faith of their words. There is no hint of the new methods and positive policies, of international co-operation between primary and industrial producers, of a rising standard of life, the equation of consumption with production and not the restriction of production to available consuming power, of a fuller flow of international lending to develop the backward regions of Asia, Africa and America, and of the repayment of world debts in goods. They tend indeed to return to the theories and practice of a restrictive, not of an enterprising past. Anglo-American co-operation seems to be viewed with anxiety.

When set against the American report, the despondency of these reports is remarkable. Of the strength and resources of Britain they give no hint. The spirit and ability that have proved her salvation since the darkest days of 1940 are passed over as if of no account in the post-war world. Britain's greatest asset in her buying power is ignored. The value of research in agriculture is recognized, but as to industry, the Federation of British Industries report alone has a stray reference to the necessity of a most active policy of research to develop new types of

exports and to obtain maximum efficiency. Our assets of scientific and technical knowledge and ability are silently discounted. Apart from a wise reminder that it will only be possible to preserve a reasonable standard of life by hard work, and by attaching as much importance to our obligations towards the community as to the rights we claim from it, there is scarcely a reference to the need for great technical efficiency, for more output per head and the development of new techniques and industries.

It is left to the American report to correct this false impression of a decadent Britain brooding over the past, and to assess her true contribution to the technique of economic progress. The assumptions on which the American proposal is based are accepted in theory, if not in practice, by all the British reports: that the United Nations will win a complete victory; that the United States will emerge as the strongest single Power in the post-war world; and that the least America will settle for is a world in which President Roosevelt's four freedoms are reinforced with a fifth—freedom for individual enterprise. With those assumptions goes the belief that there need be no serious post-war depression, and certainly no unemployment; that there need be no major war for a long time to come; that frontiers can be reopened; and that there can be room for both democracy and economic freedom—if the United States choose.

The recommendations are set forth possibly with even more dignity in an article in *Fortune* than by Raymond L. Buell in the report itself. There is frankness and poise, judgment without recrimination, sanity and vision. The first proposal involves the abrogation of the Monroe Doctrine. There have always been some Americans, from John Quincey Adams onwards, who recognized that the Monroe Doctrine was meaningless without the *Pax Britannica* maintained by the British Navy; none the less, a pronouncement of the collapse of isolationism should not pass unacknowledged, for it clears the way to the maintenance of an alliance of the United Nations, particularly with Soviet Russia, China and Britain, to police the post-war world until it is capable of policing itself.

The second proposal goes far beyond the British reports in vision and statesmanship—the proposal that the common security policy should be accompanied by a common economic policy—the creation of a free market area. This second recommendation is that the two countries should unite their economies at once in complete free trade, and allow complete freedom of mutual migration for their respective peoples. The creation of a free market area between Britain and the United States, probably by a joint declaration as a first step, with the creation of joint administrative machinery such as a joint foreign trade council, and accompanied by the elaboration of common demobilization programmes and parallel action to forestall depressions and to promote freer trade, are intended as steps towards a larger area embracing other nations, including the Dominions, which would be invited to join on the same or on special terms. The authors of this proposal are under no illusions as to its dangers or difficulties, but they are rightly viewed in an adventurous spirit and with creative minds not entrenched in the inhibitions of the past.

No real judgment is possible upon the British reports except against the background of the American proposals. Moreover, the latter have their counterpart on the British side in a Political and Economic Planning (P E P) broadsheet on "Anglo-American Economic Policy" which appeared at the end of April, the tentative conclusions of which are strikingly in line with the spirit of the American proposals. Of the three reports, that of the London Chamber of Commerce, though somewhat nebulous, comes nearest to the American proposal.

Starting with the premise that trade barriers are not themselves the disease but merely the symptoms of the disease, and that there is something radically wrong with our economic system, it submits that it is essential, if greater disasters are to be avoided, to change the system so as to ensure that international trade shall tend to raise the standard of living of the backward nations to that of the advanced nations. International trade should be used as a means of mutual aid and advantage to those participating, and competition both within a nation and internationally should be reduced from a life-and-death struggle to healthy emulation. International trade should be an exchange of goods and services of a mutually advantageous character and should not disturb that correct balance between industry and agriculture essential both for social stability and for the health and happiness of the community.

This report shows clearly some of the fundamental problems which must be solved in our attempt to equate effective demand with supply and to eliminate under-consumption: the elimination of the fear and hostility which have been the outcome and the cause of attempts to restrict trade by tariff barriers, subsidies and other measures; the more effective internal distribution of purchasing power; the unwillingness of the primary producing countries, consequent upon their industrialization, to receive imports of manufactured goods previously imported freely; the migration from over-populated to under-populated countries; and the strain which results from the existence of nations with different internal economic systems. There is a healthy note in the Chamber's observations on agriculture, which show that its support should be forthcoming for those measures of re-planning the land which the Ministry of Planning will assuredly be called upon to introduce. For all this, there is little that is positive in the recommendations of the report, which goes no further than to recommend the establishment of appropriate machinery to ensure that slumps may be forestalled through close co-operation between industry and the central bank.

The report of the Association of British Chambers of Commerce, in spite of the warm welcome to clauses 4 and 5 of the Atlantic Charter, with which it starts, is timid in places, but there are unmistakable signs of a new spirit and outlook breaking through its alarms. The Association is prepared, for example, to see the decimal system established as the universal

system of coinage, and it urges the Government to take immediate steps for the preparation of widespread schemes of colonial development and an extension of facilities for migration from Great Britain to other parts of the Empire. It presses for early steps to ensure the closest co-operation between the British Empire, the United States, the U.S.S.R. and all our other allies to provide a more equitable distribution of food and raw materials and a more orderly control of the world movement of manufactured goods. Moreover, if the report is silent as to the need for industrial research and development, it reaffirms the recommendations of its earlier report on agricultural policy in regard to extending the scope of research and making its results more simply available. The importance of agriculture as a major industry is recognized, and adoption of a well-balanced mixed farming policy is recommended, leaving grain crops principally to be imported.

Of the three reports, that from the Federation of British Industries is the clearest in the presentation of the issues, although like the others it falls short of concrete proposals. The first point submitted is that whatever the future form of co-operation in policing the world may be, it is essential that the democracies and other peace-loving nations of the world should take a continuing and permanent interest in ensuring the maintenance of a sufficient force to curb aggression, and that they should be prepared to use that force without hesitation or delay. Otherwise any post-war economic structure will be founded on a quicksand. Reconstruction at the end of the War may be visualized as possessing three aspects. First, the humanitarian phase, that of the immediate relief of stricken countries by the provision and distribution of food, clothing and medical aid to avert famine and pestilence. Secondly, that of economic relief, covering assistance to prevent economic collapse, the restoration and maintenance of essential services, including public finance. The third represents the re-shaping of our own economic life in relation to the needs of other countries, and the elaboration of a system of international trade.

The first two are clearly matters for international collaboration, and, as Viscount Cranborne indicated in his reply for the Government in the House of Lords debate on post-war settlement on June 2, are already receiving the active attention of the Government. The Federation of British Industries in its report submits that co-operation with our allies during the War is the necessary starting-point for eventual wider international collaboration, but that continuing co-operation is also required, inspired by the will and determination to maintain it over a period of years ; it must be sufficiently close yet elastic to enable methods to be suited to unforeseen changes in conditions which may arise from time to time.

A basic principle of reconstruction is that of increasing world purchasing power, and the Federation recognizes that control and restriction of production cannot by itself form a basis for an increase in world prosperity. It submits that serious attention should be given to the development of the Colonial Empires and such areas as China, less from the point of view of the provision of primary products for world use than from that of encouraging developments likely to improve their standard of life. Again, the Federation submits that industry desires the prosperity of agriculture, which is necessary in the national interest, but that the post-war planning of industry, both in regard to home and to overseas trade, will be so vitally affected by the agricultural policy followed in Great Britain that it is essential, if industrial policy is to be on a sound basis, that a decision should be reached, with the least possible delay, as to the future agricultural policy of the country.

Despite an able analysis, the Federation makes no concrete suggestions in regard to the nature of that policy, and similarly its admirable discussion of the many factors involved in national reconstruction, of Government control of industry—the necessity for the continuance of which during the immediate post-war period is admitted—the finance and organization of industry, and of the home market, issue in scarcely one constructive proposal, if we except the attention directed to the important question of the financing of industrial development after the War. This is the more disappointing because the spirit and outlook of whole sections of the report are admirable and balanced, and indicate unmistakably how large is the Government's responsibility for giving a lead and guidance to industry in this matter of reconstruction. The future organization of industry should always be subject to the overriding principle that it must be in the national interest ; finance should be the servant of industry, and not the master—these are unexceptionable principles. But if industry is to take the part in determining its own future organization which the Federation believes it should, industry must not wait upon the Government to take the first step, but by considering all the implications of industrial organization must be prepared with schemes for the more permanent association of Government with industry, which will provide the safeguards required alike in the interests of the nation as a whole and for the stimulation of individual effort and enterprise.

The magnitude of the administrative problems involved in any aspect of reconstruction can scarcely be exaggerated, and the success of whatever measures of reconstruction may be initiated will largely depend on the personnel to whom their administration and execution are ultimately entrusted. In that lies the best hope for the future of the organization now being established for inter-Allied co-operation in the conduct of the War. As the machinery now serving our immediate war purposes brings together the administrators, industrialists and men of science of the United Nations, it prepares the way for the establishment of like machinery for the attack on common problems after the War. It assists the development of a common outlook and demonstrates the possibilities which lie before us when concrete problems are attacked. The new plans which have just been announced to complete the organization for the most effective use of the combined resources of the two countries are an impressive illustration of this.

The Combined Production and Resources Board has been set up under Mr. Donald Nelson and Mr. Lyttelton, and working in close collaboration with the Combined Chiefs of Staff Committee, to ensure the continuous adjustment of production to the ever-changing requirements of the military situation. The Combined Food Board will work in Washington under the direction of Mr. Wickard, the United States Secretary of Agriculture, and Mr. R. H. Brand, chief of the British Food Mission in the United States, proceeding on the principle that the entire food resources of Great Britain and the United States are to be regarded as a common pool about which the fullest information will be exchanged. It needs little imagination to see in such developments a token of the administrative network of international social services which will be required to save Europe from anarchy, famine and disease. Moreover, the treaty between Great Britain and the U.S.S.R. is clear proof that this emphasis upon the combined role of Britain and the United States in war and peace is no derogation of the part that must be played by other great countries. The Combined Food Board, for example, will co-operate with all the United Nations in the use of food resources, as well as collaborate with all the other interested nations in the world in the development, expansion, purchase and use of their foodstuffs.

The importance of making every step fit in with the wishes and interests of other countries is not easily overstressed. For winning the War, or the peace to follow, there must be a basis of all-round trust. The gravest danger is that of petty nationalism on the part of any single country or any single group in any country, and for all the new outlook and spirit in the British reports on reconstruction, they show evidence of a lingering of a nationalist outlook and of a tendency to maintain national claims. The broadsheet on planning issued by P E P is therefore specially welcome as evidence to the contrary of the acceptance in Great Britain and in the United States of international economic collaboration as the condition of a real peace, based on freedom from want.

What is required, according to the planning broadsheet, is the continuous working out, at all levels and on both sides of the Atlantic, of economic principles and methods able to show results in increased and more widespread consumption of goods and services satisfying human needs and in security for occupied populations. A promising approach would be for those interested on both sides of the Atlantic to try to agree on a broad statement of economic purposes, and to develop on this basis a realistic contemporary code of economic behaviour and a calendar of economic crimes. An authoritative international tribunal to deal with disputes as to the 'unfairness' of particular acts, some kind of standing Anglo-American combined economic adjustment board to keep policies aligned and to remove sources of friction, and some sort of general welfare staff, national and international, combining broadly the duties of the new British Production General Staff and those of a social security board are further suggestions.

It is possible to see in recent developments the germ of the organization from which such bodies might evolve. The broadsheet shows, however, what is even more important—the need for creative thought, for courageous forward-looking minds. As to the hopes, the new outlook and new spirit which have already been aroused, there can be no question. If reconstruction is ever to satisfy those hopes, and if there is to be built a new order in which the four freedoms are firmly enshrined, it can only be as men bring to that task determination, vision, courage and magnanimity commensurate with their hopes, and with the effort now being made to gain the victory which must first be won.

NATIVE MEDICAL PRACTICE IN AFRICA

Native African Medicine

With Special Reference to its Practice in the Mano Tribe of Liberia. By Dr. George Way Harley. Pp. xvi+294. (Cambridge Mass.: Harvard University Press; London: Oxford University Press, 1941.) 20*s*. net.

NATIVE African medicine is still an unexplored territory, and it is doubtful if any single individual can arrive at a sound evaluation of native medical practice in any particular area. This would require an entire mission of persons qualified in chemistry, botany, medicine, anthropology and a few other sciences. Nevertheless, a good deal of preliminary investigation has been accomplished by individuals. Thus in South Africa considerable progress has been made in the work of determining the active principles of native drugs and of studying them chemically and experimentally on animals. J. M. Watt and M. G. Breyer-Brandwijk in 1932 published a volume on medicinal and poisonous plants used by the natives of South Africa, with information on 1,713 species which had been investigated in various laboratories. In 1934, D. G. Steyn published a work on the toxicology of plants in South Africa, and in West Africa there is J. M. Dabziel's "The Useful Plants of West Africa", with notes on the medicinal use, by natives, of more than seven hundred species; and so on.

In the present work, Dr. Harley, a medical missionary who has lived for twenty years in the closest contact with the natives of Liberia, and in particular with those of the Mano tribe, makes a valuable contribution to the knowledge of native medicine in its broader aspect. Although he does not appear to include himself in the ranks of 'anthropologists', his work is as much a contribution to anthropology as it is to medicine. This is because native conceptions of disease and native curative practices are intimately bound up with religion and magic; indeed, in order to understand them, it is necessary to have a knowledge of the whole culture of the people concerned. Dr. Harley has this knowledge.

The Mano term for medicine is *nye*, and although there is a tendency to limit this term to rational measures for curing disease, "it is extended in a loose way to include poisons, fetishes, charms and even black magic. Anything with a hidden power under the control of the user is *nye*". To the Mano man

the medical and religious or magical elements of *nye* are never completely separated, and if he cannot deduce a cause for a pathological condition from his own everyday experience, he looks for it in the supernatural.

Among Mano remedies which we would describe as rational are ointments, poultices, mud baths, sweat baths, eye-lotions, fumes for headaches, splints for fractures, incisions over abscesses, and the use of counter-irritants. The treatment for poisoning consists largely of emetics and cathartics, as well as the use of precipitants such as tannic acid and rubber latex. (Dr. Harley has very little to say about antidotes.) Surgery is limited to bone-setting, bloodletting by small, shallow incisions, circumcision and scarification of tribal marks—the last two being performed in the secrecy of the Poro and Sande Societies. There is also a practice closely parallel to our custom of performing an autopsy on cases in which the cause of death is obscure. The native leech will open up a cadaver and remove a diseased organ, especially if this organ had been the seat of a tumour which was recognizable before death and supposed to be witch-substance. The diseased organ will be removed and buried separately, so that the spirit of the deceased will not transmit the disease to some other member of the family.

Cases of smallpox are isolated, but inoculation is not practised by the Mano, though it is by numerous other tribes in West Africa. In some areas of Africa inoculations are also given against snake bite. In speaking of the widespread custom of drinking the ink used in writing verses of the Koran, Dr. Harley says that "the possible value of this ink must be attributed to the herbs from which it is made". But the practice is surely pure magic and nothing else. Again, in speaking of the practice of giving sun baths to babies, Dr. Harley observes that "whether this sunning is responsible or not, there were only three recognizable cases of rickets in a series of 8,291 admissions to the Ganta dispensary". But the cause of rickets is well established and sunning can scarcely be a cure.

Chapter 6 deals with the magical treatment of disease, and Chapter 7 with treatments that are partly rational and partly magical. "There is", says Dr. Harley, "no assurance that any particular remedy is used for its drug content, and not for some fanciful resemblance of leaf, seed, flower or thorn to the lesion of the organ which is the seat of disease. . . . Yet there is no doubt that most of the remedies included under the discussion of rational treatment have therapeutic value." But some critics might consider that no sufficient evidence had been adduced to justify this wide generalization.

The succeeding chapters deal with the treatment of snake bite, the Snake Society known as Ba Kona, and the Poro Society which is largely a 'medicine' society. There is a great deal of new information in these chapters. The treatment for snake bite is difficult to evaluate, being a mixture of the rational and the magical. Even the piece of bark tied above the wound would appear to be doubtfully described as a 'tourniquet', since it seems to be regarded as a 'ring' for warding off evil. It is said that members of the Snake Society catch and tame any kind of snake except the spitting cobra.

There is an interesting chapter on black magic and poison, and another on divination. The method of manipulating the well-known ordeal of boiling oil is explained. If the accused was to be found innocent, some water was added to the oil, the water stayed at the bottom of the pot and boiled first, giving the appearance of boiling to the oil while it was, in fact, still comparatively cool.

In his summary of diseases showing types of treatment differentiated as 'rational', 'magical' and 'mixed', Dr. Harley estimates that 65 per cent of the diseases have treatments which are clearly rational. Only thirteen out of ninety-nine diseases are lacking in any indication of at least partly rational treatment. But the system of classification is scarcely scientific, since many of the native names for diseases are merely rough descriptive phrases. It cannot be supposed, for example, that there are special native treatments for 'liver abscess' or 'malnutrition'.

The book concludes with a valuable supplementary chapter on native medical practice in Africa as a whole, and there are also a bibliography and a botanical list of the plants mentioned in the text. The bibliography omits a number of books which Dr. Harley could have used to advantage. Meek's "A Sudanese Kingdom", for example, should have been included, as this contains an entire chapter devoted to medicine and witchcraft among the Jukun of Nigeria, who appear to have a great deal in common with the Mano and even to share some of their terms. Another noteworthy omission from Dr. Harley's work is any discussion of the phenomenon so characteristic of West Africa, namely, 'possession'.

These criticisms do not alter the fact that Dr. Harley has provided a first-rate text-book on native African medicine.

THERMODYNAMICS AND CHEMICAL ENGINEERING

Thermochemical Calculations

By Dr. Ralph R. Wenner. Pp. xii+384. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 28*s*.

THE application of the concept of equilibrium to industrial processes involving gaseous reactions and changes of state has met with such success as to encourage a more extended use of the thermodynamic method in other directions, and numerous attempts to do so have been recorded in the literature in recent years. A great deal of ingenuity has been expended in overcoming some of the more obvious limitations of the method; for, apart from the lack of essential data, there are difficulties of a fundamental kind due to the fact that no 'real' system is in true equilibrium with respect to all the possible changes which may occur within it; and industrial processes generally include a time factor which is not taken into account in the thermodynamic treatment.

It can be seen, therefore, that Dr. Wenner has set himself a formidable task when he undertakes to satisfy the investigator who, "attacking problems of pure and applied science, seeks the specific thermodynamic methods which are applicable to his problem and the data requisite for its solution". It is only fair to say that he succeeds better than might have been expected. The reader may regret certain important omissions from the theoretical part of the book and he will recognize the practical difficulties which have led the author, on occasions, to adopt procedures which, at best, must be regarded as dubious. But he will also pay tribute to the care which has been taken in the selection and working

out of problems illustrating unit processes in nearly every branch of chemical technology.

The notation and theoretical treatment employed throughout the book are those familiar to American students. The fundamental thermodynamic quantities chosen are the "characteristic function"—total energy, with the independent variables, entropy, volume and chemical content; the remaining functions are then expressed in terms of the characteristic function and its differential coefficients with respect to the three variables. The earlier chapters deal with the thermal effects accompanying changes of state, solution processes and chemical reactions and with equilibria.

One of the essential requirements in applying the thermodynamic method is to be able to predict with some certainty changes in the values of the appropriate functions over a wide range of experimental conditions. In most instances this may be done from a knowledge of the heat capacities of the components of specific systems between the absolute zero and the working temperature, the enthalpy changes associated with any changes of state occurring between these two temperatures and the heat of formation of each component at some stated temperature.

The significance of these changes, particularly in systems of more than one phase, is by no means obvious from tabulated data, and simple graphical representation is to be recommended wherever possible. It is to be regretted that Dr. Wenner neglects this method. In the chapter on the liquefaction of gases, for example, processes of refrigeration, compression and expansion are worked out by the aid of thermodynamic relationships and formulæ which are cumbersome to use and fail to give any clear picture of what is happening. The construction of the relevant thermodynamic diagrams, on the other hand, is not difficult and constitutes a most instructive exercise for students; it merely consists in selecting any two of the variables p, T, H, S and V as co-ordinates and plotting a series of curves along which the other properties remain constant. It is immaterial which pair is chosen since, in principle, all such diagrams are equivalent, but for general purposes the (H,T), (T,S) and (H,S) diagrams are the most convenient. Data for most industrial gases are usually available or may be calculated with sufficient accuracy by well-known methods.

In dealing with physical and chemical equilibria methods based upon the concepts of 'fugacity' and 'activity coefficient' are employed. These quantities are evaluated from experimental data or from an appropriate equation of state. In recent years redeterminations of the compressibilities of all the more commonly employed gases and vapours have been carried out with a degree of accuracy sufficient to permit of the graphical computation of such derivatives as $(dv/dp)_T$, $(dv/dT)_p$ and $(d^2v/dT^2)_p$. The isothermal data may be expressed by empirical series equations in which the product pv is developed in terms of powers of p with the requisite number of constants to cover the whole range of the experimental observations, or by semi-empirical equations of state in which the constants are fewer in number and can be assigned some kind of physical meaning. Dr. Wenner favours the latter; but there is little to choose between the two types, provided always it is understood that they are valid only over restricted ranges of temperature and pressure. Where no experimental data are available, the law of corresponding states (based upon an equation with two constants) can be used to give a rough estimate of compressibilities.

From a knowledge of the sign and magnitude of the free energy and entropy changes resulting from a specific process carried to completion, and the corresponding figures for any secondary processes which may occur simultaneously within the reacting system, it is possible to fix within reasonable limits the temperature and pressure likely to favour the change it is desired to bring about. In this connexion two chapters are devoted to indirect methods of estimating free energies and entropies based upon the Third Law and upon the statistical interpretation of entropy.

The chemical engineer, however, has not only to assure himself of the thermodynamic possibility of such a process, but also to decide whether the physical or chemical changes involved in it can be made to proceed at measurable and useful rates under practical working conditions. As already mentioned, thermodynamics fails to give a conclusive answer to this question; but it does afford indications which enable a forecast to be made of the factors most likely to influence the result in the desired direction.

As Dr. Wenner rightly points out, there is scarcely any instance in which the complete elimination of the preliminary thermodynamic analysis of a problem in chemical technology can be justified by the absence of essential data; and he emphasizes this view by suggesting wherever possible alternative indirect methods of computing thermodynamic functions from molecular structure, spectroscopic and other physical data.

The book concludes with a section containing some sixty unsolved problems suitable as class-room exercises.

D. M. NEWITT.

NEW LAMPS FOR OLD

What the Future Demands of Religion

By R. F. Delancey Wellbye. Pp. ix+182. (London: Watts and Co., Ltd., 1942.) 5*s*. net.

THE question which Mr. Delancey Wellbye sets at the beginning of his book, and answers in the affirmative, is this: "If God and an after life are set aside as probably unprovable but anyhow irrelevant to the conduct of this life, and if the miraculous is discarded as incredible and needless, do the elements of a satisfying and sustaining religion exist?"

Mr. Wellbye finds such a satisfying and sustaining faith in an evolutionary philosophy, for which the universe, and especially our world, is 'intensely dynamic', and for which the human individual, caught up in the cosmic drive, is the growing-point of progress. Man is part and parcel of the creative evolutionary process, its agent as well as its offspring, fulfilling his nature by co-operating with it. Man's nature is fourfold: he is a creature that (1) reflects, (2) feels himself to be a 'self' with an inner life that matters more to him than the outside world, (3) is co-operative and friendly by nature, and (4) has a personality which is not something given or fated, but continually enriched and changed by absorbing experiences. It is by developing these various potentialities that man enriches his personality and so becomes actually the dominant form of cosmic activity. Mr. Wellbye claims that "This vision of a universe in action, and of man within it, its agent and destined in all likelihood to become the dominant form of cosmic activity on this planet—this is a vision

by which man can live, finding life good, and proud in the faith that human and cosmic destiny entwine".

Such being Mr. Wellbye's philosophy, his ethic is realistic. Goodness is appropriate action—action naturally taken if the circumstances are envisaged as they actually are, and not simply as they appear to a vision limited and distorted by self-interest. If conduct is based on valuations or estimates of fact which are false, disaster inevitably follows, for successful action proceeds from a proper adjustment to reality. Thus desire has to be revised and corrected in the light of understanding, which is defined as "the ability to see through the meaningless world of appearance to the significant world as it is in relation to human activity". Thus Mr. Wellbye's scheme of things gives an absorbing purpose to human life and bases conduct upon an understanding of reality.

It will be seen that the view of humanity outlined in these pages is a favourable one, and this in spite of the strong temptation which present circumstances offer to take a contrary view. Unfortunately, much orthodox religious apologetic is now taking the pessimistic point of view, which is also the obvious one. Mr. Wellbye does not base his views on mere sentimentalism but on the anthropological researches which have exploded the popular myth that primitive man was a savage cave-dwelling individualist, but established him rather as a kindly co-operative creature, who had to be educated in cruelty by civilization. That our own civilization educates us in egoism can scarcely be denied. If institutions are the product of man, it is no less true that man is also the product of his institutions.

Mr. Wellbye, though one can sympathize with his motives, is possibly less than fair to the traditional religious point of view; for example, we doubt if any instructed Christian would really hold "that what is good and what is wicked in human conduct rest finally on the arbitrary will of God". He would be much more likely to say with Mr. Wellbye himself that morality is behaving in accordance with the nature of things, about which there is certainly nothing arbitrary. Nor is it historically true that "the Christian Church has invented the category of sin". Sin is indeed a specifically religious and not merely a moral conception, but it is one which was widespread in the pre-Christian period, as the works of Prof. Angus, whom Mr. Wellbye names in his bibliography, show. The fact that the idea has been over-stressed does not divest it of truth. Mr. Wellbye emphasizes the importance of sensitiveness as a means of enriching personality, and the absence of all 'sense of sin' is a form of moral insensitiveness. It is not only physical ills, such as a toothache, that make a normal man feel uncomfortable. Mr. Wellbye also speaks of the capacity to absorb and use our experiences so that they change us; one of the positive achievements of the traditional religion has been that it has enabled people to convert adverse and disagreeable experiences into a means of enriching life and endowing it with new graces. There are those who, "going through the vale of misery use it as a well, and the pools are filled with water". Too many critics of the traditional religion have failed to recognize that it has satisfied a far larger variety of human needs than has any *ad hoc* system of ideas. Christianity is a pool where elephants may swim as well as lambs drink, and seems a different place to either. Perhaps Renan was not far wrong in saying that few people have the right to disbelieve in it.

The fact is that the constructive half of Mr. Wellbye's book is better than the critical half; and that is a good deal more than can usually be said of books of this character. His attempt to outline a new way of looking at things (which is perhaps not so new after all) is vigorous and stimulating.

J. C. HARDWICK.

HIGHER ALGEBRA

The Tutorial Algebra

By Dr. William Briggs and Prof. G. H. Bryan. Revised and rewritten by Dr. George Walker. Vol. 2: Advanced Course. Fifth edition, revised and rewritten. Pp. viii+599. (London: University Tutorial Press, Ltd., 1942.) 12*s*. 6*d*.

THE first volume of this standard work, published in 1940 in a revised and rewritten form, covered the algebra prescribed chiefly for the intermediate examinations of the University of London. The present book takes the work to a higher stage, and this additional volume was rendered necessary owing to the rapid expansion of the subject and, therefore, the need for the incorporation of a large quantity of new matter.

Volume 2 carries the course from infinite sequences and series to the theory of equations. The more advanced algebra required for London Intermediate Economics Examination and by students preparing for the several Higher School Certificate examinations is thus adequately provided in 542 well-filled pages of clearly written text. The binomial theorem, the exponential and logarithmic series, convergency, complex numbers, recurring series, summation, determinants, elimination and the theory of equations are all dealt with in a rigorous, comprehensive and skilful manner. The principles developed are excellently illustrated by aptly chosen examples, and the methods of solution are, in general, models of conciseness and elegance.

Indeed, in so many ways is the treatment so good that even more would seem to be desirable. This is particularly the case in the consideration of the biquadratic, although reference for more detailed discussion is given on p. 508. From a practical point of view, the quartic equation is becoming of increasing importance; yet rarely is a complete analysis of it to be found. It is therefore somewhat disappointing to find that no real development of the discriminant of the quartic, like the corresponding treatment of the cubic, is included in this valuable book. Incidentally, example (2) on p. 510 appears to require some clarification. Is the condition $ac-b^2>0$ sufficient to indicate the presence of at least two imaginary roots in a given biquadratic? The equation, $x^4-4x^3-35x^2+122x-168=0$, has two real roots, -6, 7, and two imaginary roots, $\frac{1}{2}(3\pm i\sqrt{7})$; yet $ac-b^2$ is negative.

Only one other point need be mentioned: this concerns the determinantal equation on p. 511 which yields the reducing cubic in $\lambda\lambda'$. As the text reads, the student is given no hint that this equation is the eliminant of the separate coefficients, λ, λ', μ, μ', after each of these has been expressed in terms of the unknown $\lambda\lambda'$.

However, apart from these points and the few misprints noticeable, the revised edition of this work can be confidently recommended as a thoroughly good and sound course in modern algebra. F. G. W. BROWN.

Handbook of Technical Instruction for Wireless Telegraphists

By H. M. Dowsett and L. E. Q. Walker. Seventh edition, extensively revised and enlarged. Pp. xx+664. (London: Iliffe and Sons, Ltd., 1942.) 25*s*. net.

IN such a rapidly growing subject as radio communication, a technical book which has survived to a seventh edition must first have possessed a very sound basis in its original form, and secondly it must have been very wisely kept abreast of the subject by its authors. All wireless operators of the pre-1914 vintage will remember the first edition by J. C. Hawkhead; this book was a standard work of its time for all would-be operators studying to qualify for the Postmaster-General's certificate. The latest edition maintains the traditions of its forerunners in providing for operators and engineers a complete course of instruction in the general principles and practice of marine wireless communication.

The work has been brought as fully up to date as is possible in a field that is not infrequently disturbed by novel applications of a somewhat revolutionary nature. It deals with the whole range of a ship's communication equipment from the power supply to the transmitting aerial, and from the crystal detector or valve receiver in a small ship to the elaborate loud-speaker installation and public address system in a luxury liner. The technical treatment also covers such aids to navigation as direction finding, depth sounding and distress call apparatus. One of the main features of the book is the large amount of photographic and circuit diagrammatic material given on all types of commercial radio-marine equipment in use at the present time. In view of the somewhat long life possessed by some of this equipment, the authors appear to have overcome successfully the difficult task of replacing obsolete material by descriptions of current designs, without making the resulting book unduly large.

The volume may be thoroughly recommended to all who are concerned with marine radio communication, not only to assist them to pass their qualifying examinations, but also as a work of reference during their active careers.

A Check-List of British Birds

With a Short Account of the Status of Each. Revised edition. Compiled from "The Handbook of British Birds". By H. F. Witherby. Pp. 78. (London: H. F. and G. Witherby, Ltd., 1941.) 5*s*. net.

AS a companion to the "Handbook of British Birds" (five volumes), the small but valuable "Check-List of British Birds" has just recently been prepared by Mr. H. F. Witherby. This list of British birds is reprinted from the "Handbook": it is set down in the briefest possible form; for fuller particulars the "Handbook" itself must be consulted. No fewer than 424 species of birds have been admitted to the British list; of these, 219 species have bred in Britain during the present century.

The "Check-List" is clearly printed, on excellent paper, and will prove a valuable addition to the list of ornithological publications.

On p. 42 is a printer's error which may perhaps be altered in a future edition. Here it is stated that the osprey last bred in Scotland in 1902. For 1902, the year 1908 should be substituted. The last accepted nesting of the osprey in Scotland (although there is a possibility that the species has bred later) was in the year 1908, on Loch Arkaig in Inverness-shire. Cameron of Lochiel, on whose property these ospreys nested, writes to me as follows: "The Ospreys nested on Loch Arkaig in 1908. One solitary bird returned for five years afterwards, and was last seen in 1913. I believe this bird was shot in Ireland, as I myself saw a stuffed osprey in the south of Ireland, and was told that the bird had been shot in 1913. In 1907 there were three young birds in the Loch Arkaig eyrie. In 1908 the eggs were stolen."

Ospreys still visit the Highlands of Scotland on migration, and it is possible that one year a pair will remain to nest in some tree or ancient castle of an ancestral loch.

SETON GORDON.

Short Wave Wireless Communication

Including Ultra-Short Waves. By A. W. Ladner and C. R. Stoner. Fourth edition, revised and enlarged. Pp. xv+573. (London: Chapman and Hall, Ltd., 1942.) 35*s*. net.

THIS now well-known technical book was first published about ten years ago, and the fact that a fourth edition has become necessary shows that its popularity is being well maintained among the constantly increasing number of radio communication engineers and physicists. A notice of the third edition appeared in NATURE of November 14, 1936, and it is noted with some satisfaction that the opportunity has now been taken to re-arrange the chapters in a more suitable manner.

In so far as the censor will permit, the whole work has been revised and brought up to date to form a comprehensive treatise on the technical principles and application of radio telegraphic and telephonic communication on wave-lengths less than about 100 metres. A chapter entitled "Electron Oscillators" contains much new material on the various types of oscillators available for the ultra-short wave-lengths less than 10 metres. A new chapter deals with high-frequency therapeutic apparatus, and attempts to present in a clear manner the facts, as well as the very controversial claims, covering the application of high-frequency radio apparatus to medical treatment.

This new edition of the book deserves to have continued success.

Brompton Hospital Reports

A Collection of Papers recently Published from the Hospital. Vol. 10, 1941. Pp. vii+127+29 plates. (London: Brompton Hospital, 1942.) 5*s*. net.

WITH the exception of a paper on the "Persistence of Lipiodol in the Lungs after Bronchography" all the articles in these reports, of which Dr. Maurice Davidson has succeeded the late Dr. Bosanquet as editor, have previously been published in various medical periodicals. Three of the ten articles are of special interest at the present time, as they are devoted to chest surgery in war, while the rest deal with the etiology of subacute pulmonary infections and erythema nodosum, the medical aspects of chronic empyema and tumours of the lungs. An authors' index to the first ten volumes, a subject index to the first nine volumes, and a subject index to the present volume are appended.

FUTURE OF THE MILK INDUSTRY*

By PROF. H. D. KAY, O.B.E.
Director of the National Institute for Research in Dairying

THE future of the milk industry in Great Britain is the key to two matters of extraordinary national importance. Its future is, by and large, the future of national nutrition; its future is, no less, the future of British farming. An expanding milk industry is our best guarantee of a steady improvement in the health and physique of the rising generation; a declining milk industry would foreshadow the rapid re-entry of British farming into the Slough of Despond. The future of the industry is not a thing to be regarded as starting after the War. It is starting now, and developments taking place to-day and during the War are influencing and shaping it continually. In fact, the War is catalysing valuable changes in the industry which might otherwise have taken years to accomplish, though slowing up other desirable developments that some of us had hoped to see before now.

The milk industry includes what is, in terms of money value, nutritional significance and numbers engaged, the greatest of our agricultural enterprises, that of dairy farming (having at the present time a turnover of some £100 millions a year), together with one of our major home industries, that of milk processing and distribution (having a turnover of some £150 millions a year). Technically, administratively and educationally, this large industry must in the future be regarded as one unit. For present purposes I shall not consider the closely related industries of cheese, butter and ice-cream manufacture, or the large ancillary trades concerned with the preparation of cattle feeding-stuffs.

Need for Planning

Freedom from want entails forethought. Our cave-dwelling ancestors, rugged individualists all of them, may have spent a happy summer and autumn under the greenwood tree and fairly full of food, but their winters must have been extremely thin and meagre before they began systematically to plan their food supplies ahead and to till the soil.

The major half of agriculture—and by agriculture I mean continuous agriculture and not the crop snatching that has terminated in certain parts of the world in complete loss of fertility, or even in loss of the soil itself by erosion—is forethought and planning, planning not for a year, but for several years ahead. The producing side of the milk industry, founded on the all-the-year-round consumption of agricultural products by livestock, is an activity where careful planning ahead is particularly important. The matings occurring this spring are laying the foundations not merely for next winter's milk production but also for our milk supply in 1945. The education that we are giving—or not giving—our potential dairy farmers to-day is securing efficiency or piling up trouble for the 1950's and 60's. Unless we are completely dead to all the lessons which peace ought to have taught us and which the War is daily and rather painfully underlining, we must all be agreed that one of the fixed points for any post-war milk industry is that it must be organized as a unit.

* Substance of a paper read before the Royal Society of Arts on May 20.

Objectives of the Milk Industry

A planned system must have an objective. The primary function of the milk industry is now, and will continue to be after the War, to produce and distribute effectively, to all human beings who need it, when and where, and in what quantities they need it, and in the highest possible quality, a key foodstuff that is essential in certain stages of human life and of major value at any stage. Its secondary function, requisite for the performance of the first, is to provide a reasonable living for those engaged in the industry. The acceptance of this view with its stress on the meeting of human nutritional needs as the primary object of the milk industry means a fundamental change in the habits of thought of some of us, and has many implications which I cannot pursue now. One assumption, however, I must make, that any future Government of Great Britain will take over the mantle which the present Government is, I think, the first effectively to wear, in insisting that the steady improvement of the health and physique of the people, particularly of the rising generation, and the promotion of British agriculture, are two of their main and closely interlocked duties. Milk is central in both of these.

We are in the fortunate position that we can *now* give to the industry a fairly close estimate of our future national needs. As a result of a large body of experiments and surveys extending over the past twenty-five years we now know sufficiently well what is the average quantity of milk per head of the population that is needed for adequate nutrition, that is, needed to raise the nutritional level of our people to that at which optimal physical growth and development and general health (so far as they depend on nutrition) may be attained. It is not less than 0·8 pint per head per day, probably not less than 1·0 pint. At present our average consumption is just over 0·4 pint per head per day. This figure is slightly greater than the amount in Great Britain in pre-war days, but slightly less than that consumed in the very poorest of American cities.

On a yearly gallonage basis, 0·8 pint per head—taking the lower of the figures just mentioned—means 1,650 million gallons a year. Liquid consumption is evenly distributed over the whole year, so that about 140 million gallons per month, winter and summer alike, will be needed. This means a 75 per cent increase in present *winter* milk production, though only a 30 per cent increase in summer production, assuming practically no milk for manufacture.

Two objections will rise to everyone's mind. First, will not the population, even if it has the money to buy the milk, slip back after the War into the peace-time habit of a low milk demand, so that any increase in production will merely mean more to be manufactured? The second question is, will not the post-war home dairy farming industry and the purchasing power of our population both be too severely hit by war impoverishment to hope to attain anything approaching this level of supply or demand? My reply is that it would be most unwise to underestimate the speed of recovery both in general economic level and in agricultural developments of an adequately mechanized civilization like our own provided we win the War, and provided we manage to canalize, in a socially positive direction both the enormous industrial forces and the great psychological drive that will be liberated when peace is declared.

Could any part of these requirements be met by the importation of dried or condensed milk? Undoubtedly, but in relatively small part. To provide a year's supply some 800,000 tons of dried milk would be needed. The Southern Dominions, working all out on milk drying, might provide one-twentieth of this amount. Even if dried milk in the necessary quantity, flavour and ease of reconstitution could be imported, a good deal of persuasion would, in my opinion, be needed before it could be used in the household on any impressive scale. In bread and confectionery making, in the institute, canteen or restaurant, dried milk could readily be used to the limits of any visible or likely supply.

Increased Efficiency of Dairy Farming

To meet the liquid milk demands I have just envisaged, most dairy farmers in these not very large islands will have to increase their efficiency and improve their management very considerably.

The yield of milk per cow per year offers a wide field for improvement. From the 520–550 gallons of the pre-war years (now down to about 460) it could be raised in a decade or so by the use of knowledge we already possess (perhaps most rapidly by taking every advantage of artificial insemination from first-class sires) to 700–750 gallons. That this is a reasonable estimate of what can be done is supported by the fact that the yield per cow in Denmark some ten years ago was officially stated to be 704 gallons per cow. Further, by control, much of which is now possible, of sterility and other bovine diseases, the average length of milking life of a cow, now less than four lactations, could be steadily raised to six, seven or even more. Instead of being a very rare creature, the 5,000-gallon cow (that is, an average of about 700 gallons for seven lactations) would be found in most herds. To enable this objective to be more rapidly reached, not only must existing knowledge be rigorously applied, but also research in the control of cattle diseases, and particularly the physiological and pathological study of bovine sterility, pressed forward with renewed energy when some of our more immediate war tasks are ended.

We shall have to control more carefully the type of bull to be used in dairy herds. Any future scheme for the use of better sires will undoubtedly receive the hearty support of the milk-producing industry. It is of interest to remember that the Ministry scheme for licensing bulls, which was rather unwisely allowed to lapse at the outbreak of war, was put into action again at the urgent request of the farmers themselves. The use of any bull inferior to the son of a proved sire out of a high-yielding dam ought, in fact, to be increasingly discouraged in the future in any herd pretending to be a dairy herd. In addition, a simple system of milk recording, without which no dairy farmer can effectively plan his feeding, breeding or culling programme, will have to be made, if not universal, as near universal as makes no matter.

Present milk shortage is due as much to lack of knowledge as to lack of feeding stuffs. Next winter's milk production, as well as that in the post-war future to which I have been referring, depends largely on the more general practice of modern—which are at the same time economical—methods of feeding. It is to be noted that per unit of feeding-stuff consumed, the 700-gallon cow is much more efficient than the 500 galloner.

After the War, if we are able to return to, and to pay for, the importation of sufficient animal feeding-stuffs, the solution of the milk producer's winter feeding problem will be relatively easy. In any case we shall probably have to continue in part on the fundamentally sounder lines along which the War has driven us—the production of *better quality protein-rich* feeding-stuffs at home. Of these, the major ones for milk production are still good leafy grass during the growing season, which will, in the future, be extended on the average by a fortnight at each end, hay cut at a relatively early stage with as much clover in it as possible, and well-made silage from young grass or from an oats and pulse mixture. Young grass and grass products will probably continue for some years to be our main protein-containing foodstuffs for the dairy herd, and the basic knowledge that has been acquired in the last two decades as to how to improve productivity and stock-carrying capacity of grassland should enable us to meet increasing demands for the milk-production ration without encroaching too severely on other types of farming or upsetting farming balance.

Increase in Cow Population

Even if we succeed in increasing the average yield per cow from the pre-war 520–550 up to 700–750 gallons, it will only give us about 40 per cent of the increase in milk production that we require to meet human nutritional needs. In addition to increased individual yield, there will also have to be an increased dairy herd. From the present population of a little more than 3,200,000 cows and heifers in milk and in calf, it will have to increase to nearly 4½ millions.

As a result of improvements in grassland and grassland management, better knowledge of arable cropping for milk production, increasing soil fertility as the manurial output of the increasing herd steadily rises, and as artificial fertilizers are used with greater skill, this population should require little more dairy-farming acreage than does the present relatively inefficient herd.

The more the farm is self-supporting as regards cattle feeding-stuffs, the more is it necessary to put back into the soil those minerals inevitably lost in every gallon of milk leaving the farm. Concomitant with an increased milk output is, therefore, an increased requirement for lime, for basic slag and other phosphatic manures, for potash and for nitrogen.

Larger Dairying Units

Not only will there be in the future a larger population of dairy cows per 100 acres, but the average dairy-farming unit will also increase very considerably in acreage, with a decrease in the total number of holdings. The average dairy-farming unit at present is only some 12–14 cows strong, but the greater efficiency of a larger unit, where both general and specialist machines can be used to advantage, overheads spread over a larger acreage, cropping policy planned on a wider basis, disease control managed more effectively, purchases made on more economical terms, better arrangements made as regards hours of work, holiday periods and so on, needs no emphasis. It is repeatedly stated that dairy farming is a particularly onerous job. This is true while the units remain small. But with a larger unit, say one having not less than 40–50 cows in milk, where three or four men or more may be available for cow-shed work, a little organization

should make it possible for the duties of feeding, milking and day-to-day operations generally to be scarcely more onerous than those on any other type of farm.

Chartered Dairy Farmers

An organized and planned milk industry may demand in the not too distant future standards of professional competence before would-be entrants into dairy farming are allowed to use land at all. It may also insist on the squeezing out into some other avocation in which he will do less harm, of the incorrigibly dirty and inefficient milk producer. Modern dairy farming demands, in no small measure, relatively new knowledge which should be a minimum asset of any who hopes to have the privilege of using a portion of our limited farming area to the best national advantage. The idea of the chartered dairy farmer is not so visionary as it sounds. Meanwhile, until vocational farming education on modern lines —which means, of course, no educational stunt, but the combination of new knowledge with ripe and tested experience in an organized course of training —can be extended to cover the needs of the large majority of new entrants into the farming profession (instead of only about 10 per cent of them as at present) the appointment in all our dairying counties of competent dairy husbandry advisers is highly desirable.

Improved Quality of Milk

The future of milk quality has three aspects: that concerned with ordinary hygiene and cleanliness, that concerned with udder disease, and that concerned with compositional or nutritional quality. All these are closely linked up.

As regards cleanliness of production, absence of which leads, particularly in summer, to taints and souring, perhaps 50 per cent of farmers, mainly those who have been producing milk for some time and have learned the simple routine for avoiding contamination, turn out a consistently satisfactory article. As regards udder diseases, methods are now known for controlling the most important of these, streptococcal mastitis, and the national veterinary medical plan which is being put into practice on a voluntary basis should, if combined with an increase of the farmer's knowledge as to the simple methods he can himself use in the cow-shed to limit its spread, be of great assistance in diminishing the heavy toll of this disease on the quantity and the nutritional quality of our milk supply. As regards *compositional* quality of milk, practically no official attention has ever been given in Great Britain to the poor nutritional value of much of our market milk, to the great changes in its nutritive quality that may be brought about by changes in the nutrition of the cow, or as a result of chronic udder disease.

Disease

I have just mentioned one of the directions in which bovine disease affects the dairy farmer. Disease puts a gratuitous tax of at least 25 per cent on to the economic cost of every gallon of milk. Diseases, like tuberculosis and contagious abortion, which can cause human infection if the milk containing the organisms is consumed, are far less important from the consumer's point of view now that more milk is pasteurized, but are extremely important from the point of view of the dairy farmer, since they may easily ruin a first-class herd unless early recognized and checked. Some form of obligatory national veterinary health insurance seems likely in the fairly near future, together with an efficient State system of preventive veterinary medicine.

Distribution

Assuming that milk of satisfactory compositional, hygienic and keeping quality has been produced by our future dairy farmer, let us consider the next steps. He will either deliver it himself to the buyer, or more usually have the churns called for either at his farm or at some convenient place on the roadside, by the collecting lorry attached to the local collecting depot or distributing dairy. In the future the churns will contain cooled milk, well below 65° F. when they leave the farm, and will be placed, if they have to wait for a while, on a properly constructed platform with a light roof over it to protect the churns from direct summer sunshine. Transport rounds will be arranged so that such waiting is minimal. The lorries will leave clean and sterile churns on the platform, and take away the full churns to reach the collecting depot without delay. Here samples of milk will be systematically taken for the determination by quick, modern methods of compositional and keeping quality by a skilled tester working under a centrally organized and controlled milk quality scheme. On his findings fitting payment to the producer will be made. No milk, even that of poorest quality, will be returned to the producer. It will be appropriately salvaged. Slightly better milk which is of insufficient quality for the liquid milk market may be used for other purposes. The satisfactory milk will then either be brine-cooled or, better, pasteurized by the H.T.S.T. process before being sent forward immediately by rail, road, tank or churn to the distributing dairy.

In the very near future the waste of milk due to souring, which last summer reached a magnitude little short of scandalous, must be prevented. Methods for the prevention of souring, even in hot weather, have been thoroughly well worked out and are well known to many, perhaps half our dairy farmers, collecting-depots or creameries, and milk distributors. In the near future, every dairy farmer whose milk consistently fails to reach the necessary standard will be instructed on his farm by the county advisory staff on points of major importance, such as the adequate cleansing and sterilization of farm utensils, milking equipment and churns, and on methods for cooling the milk to below 65° F. and keeping it cool. Hot weather provides in an almost literal sense an acid test of efficient milk production and handling, and the milk industry of the future will be ashamed of its technical inefficiency if souring or taint production continues to occur every time there is a hot spell.

Collecting depots and distributors in trouble will similarly be assisted by the provincial dairy bacteriologist. The producer is by no means always responsible if summer souring occurs. Faulty churn washing, too prolonged transport rounds, or some other factor not within his control may be to blame.

Pasteurization Requirements

The pasteurization bogey which has caused so much controversy and even ill-feeling in the past is now satisfactorily laid. Careful scientific experiment extending over some years has recently shown, and all those competent to assess the clear-cut evidence

now agree, that properly controlled commercial pasteurization causes practically no nutritional damage to milk. In the near future it will almost certainly be a national requirement that all milk sold for liquid consumption shall either be effectively pasteurized, or shall be from disease-free animals. The methods of pasteurization which will be used for the majority of town supplies after the War will undoubtedly be the H.T.S.T. process, recently officially accepted, which offers considerable technical advantages besides requiring far less space and metal than the old 'holder' process.

A beneficial consequence of such a national requirement is that many of the dirtier milk-handling and distributing premises will have to shut down. This will save a good deal of the unnecessary and wasteful duplication of milk rounds that still persists even under present war-time conditions. It is quite absurd that in a town of 100,000 inhabitants there should be no fewer than 200 licensed distributors of milk, many of them working from domestic kitchens and back-yards under indescribable conditions. Ten distributing units, adequately staffed and hygienically equipped, could do the job far more satisfactorily. Whether compulsory pasteurization is introduced or not, careful re-inspection of all licensed milk distribution premises is urgently needed in the immediate future, with revocation of licence where ordinary conditions of decency are unattainable.

The milk-distributing, like the milk-producing side of the industry, suffers from having too many small, dirty and inefficient units. It also suffers, even to a greater extent that the milk-producing side, from a paucity—almost a complete absence—of organized technical and vocational training and advisory help. Modern milk distribution is not a robot operation which can be carried out by unintelligent and untrained personnel. One of the pressing needs of the immediate future is the organization of courses of technical training in processing and distribution of milk.

Education and Research

Any long-term view of the future of the milk industry must concern itself with (*a*) the general education, and (*b*) the vocational training of the dairy farmer, the milk distributor and manufacturer, and the housewife. The milk industry is founded on knowledge that is continually advancing and extending, and its future prosperity and ability to meet the demands which the nation will make on it will depend in large part on the rate with which new knowledge can be acquired, assimilated by the industry and effectively applied.

As regards the acquisition of new knowledge, the total number of workers dealing with the research problems of milk production, processing and distribution is very small, probably less than fifty for Great Britain. Compared with the magnitude of the industry, the extent to which it is based on scientific and technical knowledge, and the number and importance of the immediate problems, both fundamental and otherwise, that await solution, this number is almost incredibly small, able though the little handful may be, and until a year or so ago its financial resources were grossly inadequate.

One of the needs of the near future is increased facilities for semi-large-scale experiments, both on milk handling and processing problems, and in methods of milk production, with an adequate research staff to deal with them. (Research workers of the type I have in mind require from five to ten years of post-graduate training before they can tackle such problems adequately, and the training of such workers is in itself a problem which the paucity of dairy research facilities in the past has rendered acute.) At present there are in several cases only two alternatives: either to leave a piece of work at the laboratory stage of development and trust that some better equipped country or some private firm will take it up, or to endeavour to go direct from the laboratory to the full industrial scale through the good will, and at the risk of, a firm in the industry. This latter method, even at the best, inevitably involves lack of control of details, of labour and of management that may make the difference between success and failure.

For experimental work on the improvement of milk production, research facilities are still meagre. Experiments on an adequate scale in dairy husbandry and on the physiology of the dairy cow will need, in the future, the use of several large experimental herds under careful control, if they are to have a prospect of success within a reasonable time.

As regards the dissemination and practical assimilation into agriculture without too great a time-lag of the results of research, the recently founded Agricultural Improvement Council should be, both in the immediate future and after the War, of considerable benefit to the production side of the milk industry, and to a smaller degree to the handling and distributive side. The maintenance of adequate financial support for the activities of the Agricultural Research Council and the Agricultural Improvement Council, after the War, is a vital step towards securing a brighter future for the milk industry.

OPENCAST MINING

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DURING recent months the provision of sufficient coal to meet the growing needs in Great Britain of the munition industry, as well as the domestic consumer, has been exercising the minds of the public and has been the subject of considerable discussion in the Press and both Houses of Parliament. Among the many suggestions for increasing the war-time output, the winning of coal by opencast methods has been mentioned. Opencast workings or opencuts are surface excavations in which the overburden is stripped by hand or mechanical excavators, thereby laying bare the mineral, which is afterwards broken and loaded into wagons or lorries by methods similar to those used for removing the overburden. In some localities in Great Britain the conditions are known to be suitable for the successful application of this method of working and intensive prospecting may result in the discovery of more. Several estimates of the total amount of coal available and also of the amount that can be extracted in the current year have been given wide publicity, but the facts, as so far proved, suggest these figures are optimistic.

The coal seams outcrop at the surface in nearly all the coalfields of Great Britain, but in the majority of cases they have already been worked by the 'old

men' from bell-mouthed pits or else by gangs of miners during periods of industrial trouble, such as strikes or lockouts.

There is nothing new in the method, which has been practised since the early days of mining, and it is in common use in most parts of the world to-day. The brown coal of Silesia is worked this way, large quantities of bedded ironstone are produced from such operations in Great Britain itself, also ironstone in Austria, the United States and the Gold Coast, tin in Malaya and Nigeria, chrome in Turkey, coal in the United States, Australia and Bulgaria, copper in Chile and the United States. These are typical examples, which can be multiplied many-fold, of successful exploitation of the method.

In Great Britain the application of the method to coal has never before been tried, the reason being that much of the better quality coal close to the surface has already been worked by underground methods, and successful opencasting requires either a large force of cheap labour or the provision of heavy, costly, excavating machinery of various types, many of which have only become available in recent years. Such machinery has been most successfully applied to home ironstone mines where the quantity of ironstone is large and the mining conditions very suitable. The majority of the remaining available excavating plant is in the hands of public works contractors who, while skilled exponents of the art of removing ground, have had little or no experience of the much more difficult problem of selective excavation, which arises when two or more seams of coal are separated by comparatively thin layers of stone. Special machinery is needed to deal with such a problem and it is not usually readily available in Great Britain.

As a coal seam approaches the surface its quality deteriorates. The moisture content is increased and the coal substance oxidized, it becomes dull and friable and loses both its coking and gas-making properties. It resembles in many ways an inferior lignite or brown coal. A typical analysis from one outcrop showing the change in composition of the coal as the cover gets thicker is given below:

Sample	Moisture as obtained or received	Air-dried moisture	Ash	Volatile matter less moisture	Total sulphur	Cal. val. (B.Th.U. per lb.)		Carbon on ash-free dry coal	Hydrogen on ash-free dry coal
						As received	Air-dried coal		
1st strip	31	10·3	6·3	33·4	0·7	7,150	9,350	70·7	3·8
2nd strip	25	6·8	2·8	33·3	0·8	8,690	10,750	72·7	4·0
3rd strip	18	8·5	1·6	31·8	1·1	10,470	11,670	76·4	4·6
Normal seam	—	5·9	3·7	33·3	2·0	—	13,600	82·3	5·3

As a consequence of this deterioration, thorough prospecting of each site by boring or trial holes to prove the quality of the coal and, at the same time the nature of the overburden, should be undertaken before productive operations begin. Failure to undertake this preliminary investigation may result in disaster.

The nature of the overburden is important; it should not be too porous or too hard. Tough clay not containing too many large boulders makes the best top surface, and this should be underlain by an impervious shale which can be broken by the digger without the use of explosives. Harder rocks like massive sandstone may render an otherwise desirable site unworkable. Explosives often have to be used to shake the tougher rocks so that they can be removed by the excavators, but their use adds to the complexity of the operations.

An ideal site involves a horizontal seam of coal with overburden that can be stripped in one operation. Rarely, except in the United States, are these conditions found; certainly not in Great Britain. Here the conditions usually consist of a more or less horizontal seam with a gradually increasing overburden; that is, the seam outcrops on the side of a gently sloping hill or, alternatively, the seam dips away from the outcrop and the surface remains level.

The value of the product determines in peace-time the thickness of overburden that can be removed. With coal the ratio is of the order of 3 or 4 to 1; with ironstone the figure is larger. To-day in England 20–30 ft. of cover are being removed to recover 5 ft. of coal, whereas with ironstone as much as 70 ft. are taken. The general plan of operations consists of combinations of loosening, stripping and transporting of overburden and mineral. The combination selected depends upon the shape, size and depth of excavation, the type of mineral, the quantity and value, output required, the surface topography, the nature and inclination of the overlying strata. Output and method should be adjusted to the total value of the product, so as to secure a minimum cost of production, though this may be qualified in war-time if output is more important than cost.

Stripping may be completed before beginning mining, or stripping and mining may proceed simultaneously when a sufficient area has been uncovered to avoid interference between the two operations. The latter plan is the better as it reduces the initial expenditure before production begins. Stripping may be done in one or more stages, depending on the depth. The overburden must be disposed within reasonable distance to avoid haulage costs and double or treble handling at points where the dumps will not embarrass future operations. The usual procedure is to remove the overburden with mechanical shovels or drag-line excavators and lay it on barren ground behind the outcrop line. Sometimes mechanical scrapers remove the top soil and carry it away, so that when the land is reclaimed after the coal is extracted the top soil can be put back on top.

Frequently large excavators with buckets carrying 12 cu. yards at the end of an 80-ft. boom are used in the main excavation, while smaller 2-yard machines stack the excavated ground clear of the cut. After the overburden has been removed down to the top of the coal, the Americans use mechanically driven rotary brooms to clean off the remaining dirt. Then the coal is dug by small shovels of $\frac{3}{4}$–$1\frac{1}{2}$ cu. yards capacity and loaded on to conveyor belts, wagons, large or small, or into lorries, some of which have a capacity of 10 tons. These take the coal either direct to the consumer or to simple screens where it is graded into two or more sizes.

The first coal obtained, that under the thinnest

cover, is usually of poor quality, friable and breaks into small pieces quite suitable for the modern mechanical chain grate boilers, but as the cover thickens the quality improves and the average size of the product increases, so that in order to obtain its full value it has to be graded into large, nuts and slack, each of which has a definite commercial use.

Ironstone workings are usually of a more permanent nature than coal projects; consequently much larger and therefore more efficient plant can be, and is, used. The actual cost of mining ironstone is remarkably low.

The average coal prospect so far exploited in Great Britain contains up to 250,000 tons of coal, its breadth is 60–100 yards and its length $\frac{1}{2}$–$\frac{3}{4}$ mile. The overburden increases from about 12 ft. at the outcrop to 40 ft., giving an average thickness of 25 ft. for a 4–5-ft. seam. One interesting operation is working both flanks of an anticline where there are five seams of coal totalling 30 ft. in all, and these are being pursued to a total depth of 70 ft.

The largest known deposit unfortunately lies under 25–30 ft. of peat in the centre of a low valley, which was once a marsh, and the surface has only recently been drained. The difficulties of dealing with waterlogged peat and water make the proposition at present unattractive. Other outcrops which have not been touched are situated in built-up areas, public parks or allotment gardens.

Many of the outcrops in Great Britain occur under land which is suitable for agricultural purposes and in such cases care has to be taken to disturb as small an area as possible. The top soil is removed first and laid on one side, then the overburden is removed and dumped behind the excavation. After the overburden has had time to settle, it is levelled by mechanical spreaders or 'bull-dozers', field drains are renewed and then the top soil is brought back and the whole re-levelled. Experience has shown that the land, though at a lower level, loses none of its fertility and in two to three years is under cultivation again.

In some instances in Great Britain, and particularly so in America, the overburden is only roughly levelled and then planted with conifers. Flourishing plantations of larch, Scotch fir and spruce can be seen in the ironstone area.

During war-time, land for opencast work can be requisitioned under the Defence Regulations and this is usually the simplest method to employ. But various questions of compensation have to be settled. The coal owner must be paid for the coal extracted from under his land and the purchase price is generally on a tonnage basis; the colliery company that has leased the right to work the coal from its owner wants compensation for loss of rights or potential profit; the surface owner, if the land is divorced from the mineral beneath, requires compensation for damage to his land, loss of rent and amenities, while the farmer is denied, for the time being, the opportunity of cultivating the area in question.

Another point that has to be settled is transport. In some instances the coal can be loaded into lorries and carried direct to the consumer, but in most cases the railway or canal has to be utilized. This means the provision of new sidings or loading stages or, alternatively, the adaptation of existing sidings to outside traffic.

In peace-time the practice will not offer any financial attraction to operators, but in war-time, when it is essential to produce every ton of coal, it is worth pursuing.

IS MUSCLE CONTRACTION ESSENTIALLY AN ENZYME-SUBSTRATE COMBINATION?

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ABOUT twelve months ago an account was given in NATURE of the striking action of adenylpyrophosphate upon the flow-birefringence and viscous properties of the globulin of muscle, myosin[1]. Since the dephosphorylation of adenylpyrophosphate is believed to be the immediate source of energy for contraction, and since, in the most recent work, it has proved impossible, in spite of serious efforts, to separate adenylpyrophosphatase activity from the protein myosin (Bailey[2], Needham[3], confirming the original work of Engelhardt and Ljubimova[4]), a continuation of this work seemed necessary. Having in the meantime made further progress in the study of the physico-chemical relations of adenylpyrophosphate and myosin, we desire to make the following further interim report.

The apparatus used was partly described in the previous note. It now consists of a small annular cell with rotating external cylinder, mounted on the stage of a polarizing microscope; and a co-axial viscosimeter with glass bottom permitting optical measurements of flow-birefringence. Three variables are observed: (*a*) the intensity of flow-birefringence itself; (*b*) the extent of the anomalous viscosity (that is, the fall of viscosity at low shear-rates); and (*c*) the relative viscosity, that is, the constant level to which the viscosity eventually falls as the shear-rate increases. The flow-birefringence and the anomalous viscosity of myosin solutions are, of course, taken to indicate that the particles are of considerable length.

Since the data in the literature on the physico-chemical properties of myosin, though numerous, are rather disjointed, we had to devote a good deal of time to the systematic examination of certain effects, as background for the interpretation of the action of adenylpyrophosphate on myosin. Thus we find that in passing from member to member of the Hofmeister series of cations at 0·5*M* ($Li^{\cdot}$, $Na^{\cdot}$, $K^{\cdot}$, $Rb^{\cdot}$ and $Cs^{\cdot}$), there is no change in the flow-birefringence (hereinafter written $\triangle$), and only slight effects on the relative viscosity (η). $NH_4^{\cdot}$, however, decreases $\triangle$. The behaviour of these properties as a function of different salt molarities is very similar for $K^{\cdot}$ and $Li^{\cdot}$; $\triangle$ falls (for example, from $\triangle$ 60° at 0·5*M* to $\triangle$ 20° at 3·5*M*); while η first falls to about 1·0*M*, and then rises. (A hump is often observed at salt concentrations varying between 0·5 and 1·5*M*, which explains certain results mentioned in the previous note, but requires further study on more purified preparations.) At the higher salt concentrations corresponding to the rising limb of the curve, the flow anomaly appears to be lost. The whole picture may therefore be interpreted either as one of progressive disaggregation, or the formation of larger, unoriented, tangles; the process ending in precipitation by salting-out. With divalent cations, such as $Ca^{\cdot\cdot}$ and $Mg^{\cdot\cdot}$, though the flow-birefringence ($\triangle$) falls steadily as their concentration rises up to 0·5*M*, the relative viscosity (η) on the contrary *rises*, continuously in the case of $Ca^{\cdot\cdot}$, but reaching a maxi-

mum about 0·1*M* and then declining in that of $Mg^{\cdot\cdot}$ (see Fig. 1 *a*).

In the Hofmeister series of anions at 0·5*M*, though SO_4'', Cl' and Br' have no effect either on △ or η; I' and SCN' reduce △ and exert extensive and complex effects on η.

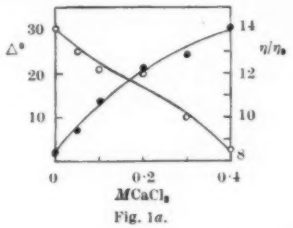


Fig. 1*a*.

The behaviour of myosin's △ and η at different *p*H is interesting. Just above *p*H 5·5, as the protein comes into solution above its iso-electric point, both flow-birefringence and relative viscosity decline from high values to a constant level reached about *p*H 6·3, and this constant level is then maintained until *p*H 9·0, at which point the two properties begin to

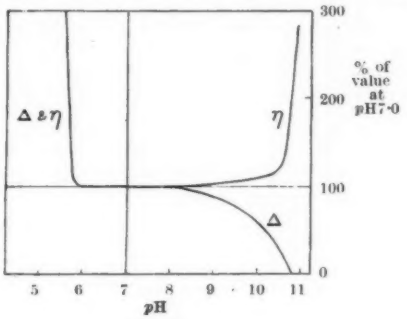


Fig. 1*b*.

diverge. Flow-birefringence falls off to reach zero about *p*H 11·0 and relative viscosity climbs to values as high as they were just above the iso-electric point (see Fig. 1 *b*). Falling birefringence with loss of anomaly and rising relative viscosity may be interpreted as disaggregation or tangle-formation perhaps accompanied by hydration.

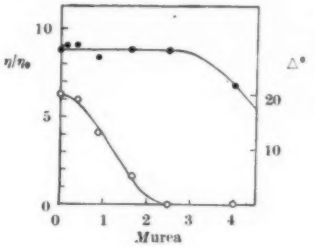


Fig. 1*c*.

Finally, with urea, in increasing concentrations up to 7 or 8 *M*, the relative viscosity, as shown by Edsall and Mehl[5], falls off to low levels. But during the range over which the flow-birefringence is falling to zero, the relative viscosity remains constant, that is, up to about 2·5*M* (see Fig. 1 *c*).

The conception generally prevailing (see Edsall[6]), that decreases in flow-birefringence of myosin are irreversible and imply denaturation, must now be abandoned. After the action of adenylpyrophosphate, △ invariably returns to its initial value; and if samples of myosin the flow-birefringence of which has been reduced by various agents are reprecipitated, the protein is found to be soluble, and the birefringence to have been largely restored. We may cite the following figures:

	△ in % of control	△ in % of control after reprecipitation and re-solution
0·5*M* LiCl	100	100
0·03*M* adenylpyrophosphate	50	74
0·1*M* $MgCl_2$	39	70
0·1*M* urea	30	100
1·0*M* urea	17	74
2·0*M* urea	10	65

After 6·0*M* urea, however, neither solubility nor flow-birefringence are regained. There are, moreover, the restorations of flow-birefringence by treatment at 37°C., described in the previous paper, but further experience (which will be described elsewhere) leads

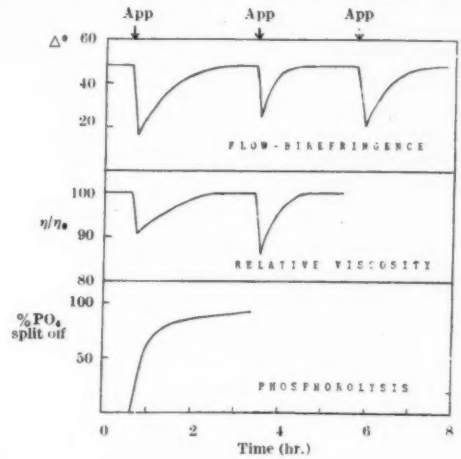


Fig. 2.

us to think that they are rather different from the adenylpyrophosphate effect at or below 20°C.

How do the effects described above compare with that produced by adenylpyrophosphate (prepared mostly by the classical method, but sometimes by that of Kerr and Seraidarian[7], which gives a purer product, freed from iron) upon myosin? When a myosin sol is treated with adenylpyrophosphate at concentrations as low as 0·004*M*, the flow-birefringence (△) is reduced by some 40–60 per cent, the anomaly is unaffected, and the relative viscosity (η) is reduced by some 20 per cent. The subsequent return of both △ and η to their original values, which may take from a quarter of an hour to several hours, according to the conditions, is accompanied by the splitting off of inorganic phosphate from the adenylpyrophosphate. The fall of △ and η is quite repeatable on the same sample of myosin—Fig. 2 shows an experiment in which three successive falls and returns of △ were observed, two successive falls and returns of η, and over the first period the splitting off of inorganic phosphate was exactly measured. The question immediately arises whether we have to deal here with a true contractility of the myosin particles. Since the

anomaly is retained, the particles must continue to be rod-like, but since the flow-birefringence is reduced, their axial ratio must be less than before. The decrease in relative viscosity would then be expected, as we know from work on polymers (see, for example, Kraemer and van Natta[8]; Powell and Eyring[9]) that η is proportional to polymer length at equal molar concentrations. But at the same time, in the absence of some sort of determination of the number of particles present, changes of aggregation and of hydration are also possible. But even were the phenomenon wholly one of disaggregation rather than true contraction, the physiological significance of the effect might be none the less.

As regards stoichiometric relations, varying the concentration of adenylpyrophosphate at 20°C. and neutral *p*H, shows that for a sol of 0·86 per cent protein approximately the full effect is obtained at 0·004 *M*, falling off very rapidly at lower concentrations, and being very little higher at amounts up to 0·2*M*. It should be emphasized that this concentration is much lower than that of any of the other classes of substances which affect myosin's flow-birefringence. To produce a 60 per cent fall of Δ, 1·5*M* urea is required, 1·0*M* monovalent cation, and 0·2*M* divalent cation; or a *p*H of 10. From the dosage data a tentative calculation can be attempted, adopting the figures of Astbury and Bell[10], including a molecular weight of 67,000 for myosin, that thirty molecules of adenylpyrophosphate are required for every molecule of myosin, or one for every nineteen amino acids in the myosin chain. Whether the fact that phenylalanine and methionine occur sixteen times in the repeat unit, and tyrosine eighteen times, may have any significance in this connexion remains to be determined. But the possibility immediately arises that adenylpyrophosphate, the actual energy-providing substrate of the contractile protein itself, may in fact be the agent of contraction, which it would bring about by its initial combination with the enzyme.

One might perhaps picture the molecular length of adenylpyrophosphate being shorter than the length between the groups on the myosin chain to which it becomes attached, so that a contraction must accompany combination. This would be in line with the general two-affinity theory of enzyme action, only in globular proteins configurational changes in the enzyme protein would not be so readily observable as in linear proteins.

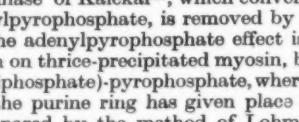
The evidence for the identity of myosin and adenylpyrophosphatase, resting upon the failure of all attempts to separate them, must remain of a negative character. But the fact that far-reaching optically observable changes in the myosin accompany the enzyme-substrate combination and the enzyme action, gives positive support to the view that the enzyme is myosin itself. It may therefore now be allowable to speak of a 'contractile enzyme'.

We should like to emphasize at this point that the viscosity data themselves suggested a specificity in the action of adenylpyrophosphate on myosin. With cations and at alkaline *p*H ranges Δ falls while η rises; with urea Δ falls while η remains constant; only with adenylpyrophosphate do Δ and η fall together to a limited and well-defined extent, which larger doses will not increase, and which is spontaneously reversed during the subsequent enzyme action. It therefore seemed important to explore more thoroughly the action of other substances which might have the same effect as adenylpyrophosphate. The following were tested at 0·03*M* with quite negative results: lactate, glucose, glucose-1-phosphate (Cori ester), hexose-6-phosphate (Embden ester), hexose-diphosphate (Neuberg ester), glycerophosphate, phospho-glycerate, creatine-phosphate, adenylic acid, inosinic acid, aneurin, aneurin-pyrophosphate (co-carboxylase), diphenyl-pyrophosphate (Neuberg and Wagner[11]), inorganic pyrophosphate, metaphosphate, hexametaphosphate.

Any substances, of similar constitution to the substrate, and which combined with the enzyme, might be expected to show some degree of competitive inhibition. They would block the fall of Δ produced by adenylpyrophosphate, and inhibit the subsequent enzyme action.

The following substances were tested, and gave no such effects: inorganic orthophosphate, pyrophosphate, metaphosphate, hexametaphosphate, diphenylpyrophosphate, adenylic acid, inosinic acid.

We were able to observe the adenylpyrophosphate effect, however, using adenosine-diphosphate (prepared according to the method of Ljubimova and Pevsner[12]), but only on relatively unpurified myosin preparations. Thrice-precipitated myosin is not affected by adenosine-diphosphate, probably because the 'myokinase' of Kalckar[13], which converts it partly into adenylpyrophosphate, is removed by this purification. The adenylpyrophosphate effect is also fully given, even on thrice-precipitated myosin, by inosinic-(inosine-triphosphate)-pyrophosphate, where the amino group on the purine ring has given place to a keto-group (prepared by the method of Lohmann[14], and purified according to Kiessling[15]). An interesting result is obtained with inorganic triphosphate (prepared according to the method of Huber[16]):



which, as Neuberg and Fischer[17] showed, is hydrolysed by muscle extract. This substance is split by the enzyme, giving inorganic phosphate, and as in the case of adenylpyrophosphate and inosine-pyrophosphate the process is accelerated by Ca^{++}, but it has no effect whatever on the flow-birefringence. Correspondingly, it does exert a certain degree of competitive inhibition on the adenylpyrophosphate reaction, diminishing (in a typical experiment) the birefringence-reduction to 63 per cent of the control, and the phosphorolysis to 46 per cent of the control.

It would appear, therefore, to be highly probable that myosin is a specific triphosphatase. Since triphosphate combines with the protein and is split without causing any fall of Δ, we may say with some plausibility that the purine-ribose end of the adenylpyrophosphate molecule is also of great importance in changing the shape of the protein molecule.

The only other attempt which has been made to elucidate the relationships of adenylpyrophosphate and myosin, which to-day seem crucial for any fundamental understanding of protein contractility, is that of Engelhardt, Ljubimova and Meitina[18]. Partially dried fibres of myosin, prepared by injection from extruders into distilled water, and still retaining some adenylpyrophosphatase activity, were treated with a variety of substances, of which alone adenylpyrophosphate showed any effect—an increase of extensibility. The concentration of adenylpyrophosphate used was similar to that found by us to be minimal for complete effectivity, that is, 0·0025*M*.

It is, of course, impossible to compare readily the results of two techniques so different, especially as the full details of the Russian work are not yet available.

In conclusion, it seems now fair to say that the interaction between adenylpyrophosphatase and its natural substrate brings about deep-seated and optically observable effects upon the enzyme's physical state. Whether these changes are micellar in character, or whether they are analogous to the configurational changes established for the keratins, remains as yet uncertain. Could adenylpyrophosphate itself then be normally *in vivo* the agent of contraction? Were this so, the reception of the nervous or other stimulus would essentially allow the enzyme and substrate to come in contact. By this enzyme-substrate combination the configuration of the contractile enzyme would itself immediately be changed (as pictured by Astbury and Dickinson[19]; Astbury[20]), and the later splitting off of inorganic phosphate from the substrate would supply the energy needed for the relaxation and recharging of the myosin fibril. The solution of these problems will be of much importance, not only for muscle physiology, but also for many other fields of biology into which fibre-properties enter, such as morphology and morphogenesis (cf. the recent work of Pollister[21] and Hobson[22]).

[1] Needham, J., Shen, S-C., Needham, D. M., and Lawrence, A. S. C., NATURE, **147**, 766 (1941).
[2] Bailey, K., *Biochem. J.*, in the press (1942).
[3] Needham, D. M., *Biochem. J.*, in the press (1942).
[4] Engelhardt, W. A., and Ljubimova, M. N., NATURE, **141**, 668 (1939); *Biochemia* (U.S.S.R.), **4**, 716 (1939).
[5] Edsall, W. T., and Mehl, J. W., *J. Biol. Chem.*, **133**, 409 (1940).
[6] Edsall, W. T., "Advances in Colloid Science", **1**, 269 (1942).
[7] Kerr, S. E., and Seraidarian, K., *J. Biol. Chem.*, **139**, 121 (1941).
[8] Kraemer, E. O., and van Natta, F. J., "Colloid Symposium Monographs", **10**, 327 (1932).
[9] Powell, R. E., and Eyring, H., "Advances in Colloid Science", **1**, 183 (1942).
[10] Astbury, W. T., and Bell, E. O., NATURE, **147**, 696 (1941).
[11] Neuberg, C., and Wagner, J., *Biochem. Zeitschr.*, **171**, 485 (1926).
[12] Ljubimova, M. N., and Pevsner, D., *Biochemia* (U.S.S.R.), **6**, 178 (1940).
[13] Kalckar, H., *J. Biol. Chem.*, **143**, 299 (1942).
[14] Lohmann, K., *Biochem. Zeitschr.*, **254**, 381 (1932).
[15] Kiessling, W., *Biochem. Zeitschr.*, **273**, 103 (1934).
[16] Huber, H., *Zeitschr. angew. Chem.*, **50**, 323 (1937).
[17] Neuberg, C., and Fischer, H. A., *Enzymologia*, **2**, 191, 241 and 360 (1937).
[18] Engelhardt, W. A., Ljubimova, M. N., and Meitina, R. A., *C.R. Acad. Sci.* (U.S.S.R.), **30**, 644 (1941).
[19] Astbury, W. T., and Dickinson, S., *Proc. Roy. Soc.*, B, **129**, 307 (1940).
[20] Astbury, W. T., *J. Chem. Soc.*, 337 (1942).
[21] Pollister, A. W., *Physiol. Zool.*, **14**, 268 (1941).
[22] Hobson, L. B., *J. Exp. Zool.*, **88**, 107 (1941).

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OBITUARIES

Prof. A. R. Forsyth, F.R.S.

PROF. ANDREW RUSSELL FORSYTH, emeritus professor of the Imperial College of Science and Technology, South Kensington, died on June 2 at Bailey's Hotel, London, where he had lived since he retired in 1923 from his position as chief professor of mathematics at the Imperial College. His age just fell short of eighty-four, as he was born (at Glasgow) on June 18, 1858.

He was educated at Liverpool College and at Trinity College, Cambridge. His student career at Cambridge was brilliant: he was Senior Wrangler, and First Smith's Prizeman in 1881, in which year also he was elected to a prize fellowship at Trinity. In the following year he became professor of mathematics at University College, Liverpool, but two years later, in 1884, he returned to Cambridge as a lecturer of his college and of the University. In 1895 he became Sadleirian professor of pure mathematics at Cambridge in succession to Cayley, whose voluminous collected papers he edited (1895–98).

While still in his twenties Forsyth attained a reputation as a pure mathematician that extended far beyond the borders of his own university and country. His distinguished researches, an account of which is given separately below, led to his election as a fellow of the Royal Society at the early age of twenty-seven, and eleven years later he was awarded a Royal Medal of the Society. In the same year he was president of Section A of the British Association at its Toronto meeting, a distinction which he held a second time in South Africa in 1905. He was president of the London Mathematical Society during 1904–6.

Besides making important original contributions to pure mathematics, Forsyth rendered a service of special value to his university in breaking the bonds of the isolation of its mathematical school, during the latter part of the nineteenth century, from the great Continental movements of thought in the subject. By his writings and his lectures he widened the knowledge and outlook of his colleagues and students, and stimulated a revival of pure mathematical learning and research in England.

Forsyth was a prolific author of books, beginning in 1885 with a text-book on differential equations, that has run through many editions, and has been translated into several languages; this was followed by a large treatise on the theory of differential equations, in several volumes (1890–1906), and by an attractive text-book on the theory of functions (first edition in 1893).

During his Cambridge period he found time also to take part in the government of the University, as a member of the Senate during 1890–1910; and in other public work, for example, as a member of the Treasury Committee on the Scottish Universities, in 1909.

For many years Forsyth was regarded abroad as the leader and representative of English pure mathematics, and honours from universities and academies the world over were bestowed upon him. He maintained many personal and official international contacts; he travelled much and was an accomplished linguist.

In the midst of his fame he left Cambridge (1910), resigning his chair and the college fellowship that meant so much to him. In painful circumstances he made a marriage of affection, and gained ten years of a happiness for which he counted the loss of many old associations a price not too high. For a time he was without any official position, and during this period he delivered in Calcutta (1913) a series of lectures on differential geometry (afterwards published as a book).

Forsyth entered on the last phase of his teaching career when in 1913 he accepted the headship of the department of mathematics at the Imperial College, combining the direction of two previously separate schools (one in the Royal College of Science, the other

in the City and Guilds Engineering College) headed by Profs. Perry and Henrici, who retired nearly at the same time. The War of 1914–18, and its aftermath, interrupted his plans for building up a new honours school of mathematics at South Kensington, and he retired from his chair in 1923, after ten years tenure, on attaining the age limit of sixty-five.

His wife had died of cancer not long before, to his intense grief; he cherished her memory most tenderly, and in his will he left his residuary estate to the Royal Society for cancer research.

In his lonely retirement Forsyth found solace in his mathematical studies, and published two further treatises, on the calculus of variations (1927) and the geometry of four dimensions (1930); he also continued his linguistic studies.

His last years were clouded by frequent illness. His thoughts dwelt much on his Cambridge days, particularly on the old-time Tripos conditions of his student period, and on the Senior Wranglers of those years. In his last illness his mind lived in this golden epoch of his youth. S. CHAPMAN.

THE old Tripos admitted of very little specialization, and a Senior Wrangler was bound to have a competent knowledge of every branch of mathematical science known to the Cambridge of his day. The emphasis was generally on mathematical physics, in which England led the world; and Forsyth's first original paper—written when he was still an undergraduate—was on the motion of a viscous incompressible fluid. Immediately after taking his degree, he began to work on a fellowship dissertation; for some time he toyed with the kinetic theory of gases, but finding this unprofitable, he turned to an idea which had occurred to him when listening to Glaisher's advanced course on elliptic functions, and in two months produced the great memoir on the double theta functions, which occupies 79 pages of the *Phil. Trans.*, **173**, and which, besides winning the fellowship, laid the foundation of his fame as an original investigator.

The subject was well suited for the display of Forsyth's most characteristic gifts: a masterly algebraical technique in dealing with vast numbers of symbols, and a wonderful power of detecting identities and relations in problems of great complexity. In the following year he wrote a long and valuable paper on a closely related subject, Abel's theorem and Abelian functions, which was printed in *Phil. Trans.*, **174**, and after this a substantial work on the Weierstrassian doubly periodic functions (*Quart. J. Math. Soc.*, **22**), which he introduced to Cambridge mathematicians (Glaisher always adhered to the Jacobian *sn*, *cn*, *dn*). It is somewhat remarkable that although a pupil and fervent admirer of Cayley, he had up to this time done nothing on Cayley's great subject, the invariant-theory of algebraic forms; and when he did come to it, in 1887, it was not directly but by the roundabout way of differential equations. In a single year, 1889, he published five papers, totalling 284 pages, on the concomitants of algebraic and differential forms; and in the next year, more than a hundred pages in the *American Journal of Mathematics* on a topic in the same field, "Systems of ternariants that are algebraically complete".

The following years were spent chiefly in preparing himself for writing a book which had perhaps a greater influence on English mathematics than any work since Newton's "Principia", namely, the "Theory of Functions of a Complex Variable", which was published in 1893. This for the first time opened to his countrymen the vast development of pure mathematics which had taken place on the Continent in the nineteenth century; it broke the Cayley tradition, and led all the younger generation at Cambridge into the new domain. On Forsyth's part it was a patriotic and self-sacrificing action; for while the fresh impetus brought vigour and fame to the school, the situation was not well suited for the exercise of his special aptitudes: there was little opportunity of superb generalship with symbols, and his somewhat unphilosophical mind was at a disadvantage when confronted with the new type of problems. Moreover, by turning everyone's attention away from the subjects in which his greatest triumphs had been won, he caused what was in effect a lowering of his own popular reputation.

Another factor which perhaps likewise tended in some degree to displace Forsyth from the supreme position which he held in the general estimation at the end of the nineteenth century was the practice, which he adopted from this time onwards, of publishing most of his discoveries, not as they were made, in separate papers, but in advanced treatises (some of them of colossal size), each summing up the work of several years. Human nature being what it is, a worker on the remotest frontier of pure mathematics would probably be well advised to impart his results to the world by instalments smaller than those customary with Forsyth; few people are willing to tackle what is practically a continuous heavily analytical original memoir of eight hundred pages. But whatever may be thought of the practical wisdom of his later policy, the great memoirs of his earlier period will secure for him permanently one of the high places in the mathematical pantheon.

E. T. WHITTAKER.

Mr. W. A. Benton

WE regret to record the sudden death of William Alfred Benton at his home at Handsworth, Birmingham, on June 19, at the age of seventy-one. For many years Mr. Benton was in charge of research at Messrs. W. and T. Avery Ltd., Soho Foundry, Birmingham, and was a well-known figure in scientific circles. He was a fellow of the Physical Society and a past president of the Birmingham Metallurgical Society; among other activities he was a member of the Society of Chemical Industry, the Newcomen Society and the Wolverhampton and District Society. During the past few years Mr. Benton had been compiling a work on the history of the balance, and it is fortunate that the greater part has already been completed.

Outside his professional interests, Mr. Benton was a keen amateur photographer, and was a member of the Royal Photographic Society and local photographic societies.

WE regret to announce the following deaths:

Mrs. F. Rhys Davids, president and co-founder of the Pali Text Society, on June 26, aged eighty-four.

Lord Glanely, president of the University College of South Wales and Monmouthshire, at Cardiff, on June 28, aged seventy-four.

Sir Daniel Hall, K.C.B., F.R.S., formerly director of the John Innes Horticultural Institution, and for some years chief scientific adviser to the Ministry of Agriculture, on July 5, aged seventy-eight.

NEWS and VIEWS

Colonial Research Committee

THE Right Hon. Viscount Cranborne, Secretary of State for the Colonies, was present at the inaugural meeting of the Colonial Research Committee held on June 29, and defined the scope and purpose of the Committee's work (see NATURE, July 4, p. 17). He said that the Committee will have two functions. In the first place it is to advise the Secretary for the Colonies on schemes for assistance from the £500,000 a year which is provided under the Colonial Development and Welfare Act for "research and inquiry". But this is only part of a wider function; what is needed is a broad survey of the whole range of research in Colonial studies. We need to know, first, what subjects ought to be studied, secondly, what is being done now, and thirdly, what can and should be done to fill the gaps. In several respects the field is not at present adequately covered. The older sciences have in this respect the advantage; but there are newer sciences, the application of which to Colonial questions has not at present gone very far. Many of these could render work of immediate practical value to the Colonial Empire.

Lord Cranborne then emphasized that the Committee should undertake "inquiries". There will undoubtedly be many applications, he said, from Colonial Governments for assistance in making inquiries that will be of immediate practical value to them—jobbing inquiries that the pure scientist may rather scorn to describe as research proper. The Government's intention, however, is that the Committee should include all forms of inquiry in its field—the ascertainment, collection and assessment of all facts that may be of value to the Colonial Empire. This is not to be interpreted, however, as limiting investigations to research of immediate application to Colonial problems. In attempting to define "Colonial studies", Lord Cranborne pointed out that while there is little that is common to all parts of the Colonial Empire, there are some things that are common to large parts of it. For example, most of the Colonies are in the tropics, they are engaged in primary production, in agriculture rather than in industry. Most of them are maritime, and many parts of them are inhabited by peoples who have only recently come into contact with Western civilization. Hence questions relating to tropical health, agriculture and engineering, fisheries and all questions relating to the development of peoples in contact with more advanced civilizations are of interest to the Colonial Empire and thus to the new Committee. Finally, there are large groupings of the Colonies geographically. There are, for example, many Colonies in Africa; all scientific questions relating to Africa, and particularly to tropical Africa, would therefore come within its range of activities.

The Committee, said Lord Cranborne, will inevitably have contacts with many others, outside the Colonial Empire itself, working on problems which are yet of interest to the Colonies. Apart from institutions in Great Britain, there are many in India and the Dominions, particularly perhaps South Africa, and many too in various foreign countries. The other Colonial Powers, for example, all have research institutions, which in happier days after the War will exist again. We share many problems and can share too in their solution—the control of locusts, tse-tse fly research, nutrition and so on. With the United States too we have already a long and happy tradition of collaboration on research matters. Scientific problems do not recognize national boundaries; they will assuredly provide, in the future as in the past, a fruitful field of international co-operation. Lord Cranborne also expressed the hope that the Committee will make it one of its objects to develop research work actually in the Colonial Empire itself. There has been in the last twenty years or so a rapid development of the educational institutions in the Colonies. The addition to such institutions of research workers, engaged primarily in the pursuit of pure knowledge without too close a concern with its practical application, is of great value in fostering an atmosphere of true learning.

Nutritive Value of Meals in 'British Restaurants'

THE feeding of the people of Great Britain during the War is based on scientific knowledge, a great proportion of which has been gained during the last twenty-five years. In the War of 1914–18 sufficient was known about calories, protein and perhaps vitamin C to ensure that these factors were taken into consideration in the choice of food supplies. Disaster, however, might well have overtaken us through ignorance then of requirements of vitamin A. Those who advise the Ministry of Food to-day must therefore use what information they can acquire to ensure, in this War, that no deficiencies of, say, pantothenic acid, vitamin B_6 or biotin affect the national health.

Meals served in British Restaurants represent in many cases a substantial part of the diet of those eating them, and an investigation of the nutritive value of the food actually served on the plates is calculated to give information of great importance. To get such information the Ministry has enlisted the co-operation of a number of scientific workers in universities, hospital laboratories and elsewhere. Each of these workers has taken the responsibility of overseeing each month the type of meal served in his area. In addition, each will analyse the meals for vitamin C at least and, where laboratories have the facilities, investigations of less well-known vitamin factors, analyses of protein or the experimental determination of calorific values will also be undertaken. As the War continues and food supplies become more restricted, it is against unexpected deficiencies that we must guard. Thus the workers who are voluntarily giving their skill and knowledge to the Ministry of Food will be making a real contribution to the national effort.

Medal Awards of the Royal Society of Arts

THE Albert Medal of the Royal Society of Arts for 1942 has been awarded to General J. C. Smuts, Prime Minister and Minister of External Affairs of the Union of South Africa. In deference to General Smuts's well-known preference for brevity and simplicity the following words will be inscribed on the medal: "Statesman. Soldier. Scientist. Philosopher".

Silver medals have been awarded for the following papers read before the Society during the past session: *Papers read at Ordinary Meetings*:—Mr. J. C. Dawes, "Making Use of Waste Products"; Prof. H. D. Kay, "The Future of the Milk Industry"; Mr. James Kewley, "Evolution in the Petroleum Industry"; Mr. E. M. Rich, "Technical Education". *Papers read before the India and Burma Section*:—Sir Bernard Darley, "The Development of Irrigation

in India"; Mr. A. J. Gibson, "The Story of Lac"; Dewan Bahadur S. E. Runganadhan, "The Work of Indian Universities". *Paper read before the Dominions and Colonies Section:* Dr. Maurice Ashby, "British Empire Drug Production". *Endowed Lecture:* The Right Hon. Viscount Bennett, "Empire Relations".

American Chemical Society Prize in Pure Chemistry

THE American Chemical Society Prize in pure chemistry of 1,000 dollars has been awarded for 1942 to Dr. John Lawrence Oncley, associate in physical chemistry at the Harvard Medical School and instructor in chemistry at the Massachusetts Institute of Technology. This Prize is given annually for "outstanding research in pure chemistry by a man or woman less than thirty-six years old". Dr. Oncley has made important contributions to protein chemistry, and he has investigated the dielectric properties of gases, insulating oils, resins, rubbers and proteins, developing radio-frequency bridge methods suitable for precise dielectric constant determinations with proteins. With the aid of these methods he completed the first satisfactory study of the dielectric dispersion behaviour of water-soluble proteins. This work constitutes one of the significant contributions of recent years to protein chemistry and has led to further studies on the molecular size and shape of protein molecules.

Award of the Dr. W. S. Bruce Memorial Prize

THE joint committee consisting of representatives from the Royal Society of Edinburgh, the Royal Physical Society and the Royal Scottish Geographical Society has awarded the Bruce Prize to Dr. G. C. L. Bertram for valuable biological work in the Arctic and Antarctic during 1932–37; and especially for his work as biologist with the Graham Land Expedition during 1934–37, when he took part in the important sledging journey which discovered King George VI Sound. His particular work was on seals, and he has written an important memoir entitled "The Biology of the Weddell and Crabeater Seals", published by the British Museum (Natural History) in September 1940 in the British Graham Land Expedition Reports. In addition, Dr. Bertram is the author of a more popular book on the technique of polar travel entitled "Arctic and Antarctic".

Bicentenary of Abraham Sharp

ON July 15, 1742, the mathematician and astronomer Abraham Sharp died at his birth-place, Little Horton, near Bradford, Yorks., at the age of ninety-one, having in various ways furthered the interests of British astronomy. After serving an apprenticeship to a merchant at Manchester, he opened a school at Liverpool, where Flamsteed met him. The meeting led to Sharp joining Flamsteed in the newly erected Royal Observatory at Greenwich where he worked from 1676 until 1690. In 1688 Sharp was given the task of constructing a mural quadrant of 79 in. radius, and this proved to be the most satisfactory instrument Flamsteed possessed. With his other instruments it was removed from Greenwich by his executors after Flamsteed's death, but some eighty years ago parts of a similar instrument by Sharp were given to the Observatory by the Rev. N. S. Heineken. On leaving Greenwich, Sharp settled at Little Horton, calculating, making instruments and corresponding with scientific men. He supplied Flamsteed with observations, and with Crosthwait, Flamsteed's last assistant, he had a share in the publication of the "Historia Cœlestis Britannica", which appeared in 1725, six years after Flamsteed died. In a letter written in January 1722, Crosthwait wrote to his collaborator that "the memory of the ingenuous and disinterested Mr. Sharp will always, by me, be had in the greatest esteem, next to that of my deceased and good friend Mr. Flamsteed".

Dr. Charles B. Dudley, 1842–1909

EACH year, the American Society for Testing Materials awards a medal for some outstanding contribution to research in engineering materials, and to commemorate the eminent services of the Society's first president, Dr. Charles B. Dudley, who was born on July 14, 1842. Brought up in Chenango County, New York, Dudley at the age of twenty enlisted in the 114th New York Volunteers, fought in a number of battles during the Civil War, and was severely wounded. In 1865 he was free to resume his interrupted studies, and during the next nine years worked at the Oxford Academy, Chenango Co., Yale College and the Sheffield Scientific School of Yale College. Part of his time was spent on newspaper work to provide him with necessary funds. On leaving Yale in 1874 with the degree of Ph.D., he devoted a short time to teaching chemistry and physics at the University of Pennsylvania and at a Military Academy at Poughkeepsie; and then in 1875 became chemist to the Pennsylvania Railroad Company, with headquarters at Altoona, Pa., where he installed laboratories. Much of his work was of a pioneering character and it gradually spread to investigations on all the materials used in the building and working of a railway, from the laying of the track to the ventilation of carriages. Especially important were his researches on rails. Besides being the founder-president of the American Society for Testing Materials, he served as president of the American Chemical Society and at the Copenhagen Congress of the International Association for Testing Materials held in 1909 he was chosen president for the ensuing three years. Soon after his election, however, he died unexpectedly on December 21, at the age of sixty-seven.

30-kw. Short-Wave Radio Transmitter

AN article by F. D. Webster and R. E. Downing (*Elec. Comm.*, **20**, No. 3, 1942) describes a new equipment built for All America Cables and Radio Inc. for use in the expansion of its international service at Lima, Peru. The equipment is capable of operating on any frequency between 5·7 mc. and 22 mc., with crystal control or with self-excitation, for carrier wave or modulated carrier wave telegraphy or by means of a separate modulator for telephone or broadcast, to deliver 1 kw. or 30 kw. of radio frequency power on telegraphy or 9 kw. on telephony or broadcast, and of delivering its rated output at any frequency between 5·7 mc. and 22 mc. into a balanced transmission line of 600 ohms surge impedance with any standing wave ratio up to 2 to 1.

Flexibility is achieved by constructing the equipment in four mechanically separate units and by the provision of controls which permit rapid and convenient transfer to any type of operation. The four units comprise a radio frequency driver, a power am-

plifier, a 3,000-volt rectifier and a 10,000-volt rectifier. For telephone operation two more units are required, namely, a speech amplifier and a modulator. Voltage breakdown, which is an ever-present hazard due to the high voltages produced in radio equipment of this power, is minimized by adequately spacing and insulating all components, by avoiding sharp edges on metal parts, and by installing corona shields and horn gaps where applicable. Excessive temperatures are avoided by employing adequate current-carrying capacity in all conductors, ample radiating surfaces, water cooling, and forced air circulation by means of blowers.

Recent developments incorporated in this equipment include electronic keying with weight control, modulated carrier wave telegraphy by phase modulation, special type balancing network, multistrand filament tube, vacuum condensers. The article gives, at some length, details of the electrical design and the mechanical construction of the general assembly of the equipment and of the component parts which come broadly under the headings of controls, personnel protection, radio frequency driver unit, power amplifier unit, 3,000-volt rectifier unit and 10,000-volt rectifier unit. A table of specifications summarizes the more detailed equipment description.

Optics Applied to Engineering

A LECTURE entitled "Optics Applied to Engineering" was delivered by Mr. K. J. Habell at a meeting of the Leicester Branch of the Association of Scientific Workers held on June 2 at the College of Technology, Leicester. Mr. Habell described the principles of several types of optical instruments now in increasing use in engineering workshops, and much interest was shown in those of the more difficult types of profile projection. The application of telecentric systems for the avoidance of magnification errors due to incorrect focusing and to ensure the imagery of the correct profile was very well illustrated by diagrammatic and experimental slides showing the images of a circular hole produced by convergent, divergent and collimated beams of light. Other instruments described included the tool-room microscope for the examination of form tools and screw-thread forms, and alignment telescopes for measuring the alignment and relative tilt of closely or widely separated bearings and jigs. Details were given of auto-collimating telescopes for high precision work in angular measurement. The importance to the war effort of instruments of the types described was emphasized. A selection of the instruments was on view, and was demonstrated after the meeting.

Chemical Engineering at Leeds

THE Department of Coal Gas and Fuel Industries (with Metallurgy) of the University of Leeds was established in 1906 to provide degree courses in fuel and metallurgy. In 1910 a fund was raised by the gas industry in order to perpetuate the memory of Sir George Livesey, the distinguished gas engineer, and this was allocated to endow the chair of the Department now known as the Livesey professorship. A degree course in gas engineering was instituted at that time. Since then the Livesey Advisory Committee, which is composed of representatives of the Institution of Gas Engineers, of the Society of British Gas Industries, and of the University, has had under consideration the need for extending the courses in order to keep pace with the growth of knowledge and the increasing demands of industry. In particular, for those passing into the constructional side of the gas industry and into the larger undertakings as well as to the staffs of chemical plant manufacturers generally, a broader training is necessary. On this account the Committee recently recommended the establishment of an alternative four-year course in chemical engineering, which has now been approved by the University; the new course will begin with the autumn term.

Domestic Electricity Supply

AN optional-control system of domestic electricity supply is described by P. Schiller (*J. Inst. Elec. Eng.*, **89**, Pt. 2, No. 9; June, 1942), which is designed to meet the objection often raised to domestic load control of any kind, in that it involves encroachment on the consumer's liberty to use his supply as he wishes. It is suggested in the paper that the consumer be given the opportunity at any moment and for any period of time readily to change over from a controlled to an uncontrolled supply, and vice versa, the consumption during periods in which the load control is made inoperative being charged at a higher price. The price change can be effected by a gear-change device in the kwh. register or in the prepayment mechanism of the meter, actuated in conjunction with the change-over in the operation of the load control. The necessary modification of apparatus and the extra cost entailed are both of a minor nature.

Siting of Power Stations

A PAPER by F. Favell (*J. Inst. Elec. Eng.*, **89**, Pt. 2, No. 9; June 1942), on the considerations to be given to this subject, points out that in recent years the siting of electricity-generating stations has tended to be affected increasingly by non-technical considerations such as legal requirements, amenities, etc. These considerations become of special importance when a particular scheme is submitted to a public inquiry by the Electricity Commissioners under Section II of the Electricity (Supply) Act, 1919. The paper records some of the issues to be borne in mind when siting power stations in Great Britain and at the same time it refers to some factors which have a bearing on power station construction irrespective of location. It is divided into two main parts, the first dealing with considerations arising out of parliamentary legislation, and the second with more technical and practical problems. The first part refers to the Town and Country Planning Act, 1932; the Coal Act, 1938; the Coal Mines Act, 1930; and various other statutory requirements. The second part deals with chimney emissions; sewage effluent for circulating water; amenities; and alternative sites.

Californian Fisheries

THE report on the commercial fish catches of California for the year 1940 (State of California Department of Natural Resources. Division of Fish and Game. Bureau of Marine Fisheries. Fish Bulletin No. 58; 1942) makes available the summaries of commercial fish landings in each region of the State and also includes tables of numbers and nationality of the commercial fishermen and the number of boats of each type engaged in the fishery. A rapid development of the shark fishery is outstanding and is caused by the high price offered for liver oils of high vitamin A potency. This increase in the shark fishery, with

intensive mackerel fishing and the large amount of sport fishing, has resulted in an increase of 350 boats in 1940–41 registrations over the previous year and is most noticeable in the group between 25 ft. and 39 ft. long. There has been a steady development of sport fishing in the ocean waters of Southern California, and the amount of small fish required as bait must be considered together with its effect on the several species used as bait. The statistical records include not only the sport catch itself but also the harvesting of the small-sized fishes used by the anglers for bait. Sardines and anchovies are the most important in the bait catch, comprising 98 per cent of the total, the fishes being 2½–6 in. long. A useful list of the common and scientific names of fishes, crustaceans and molluscs involved in the fisheries is given at the end of the report.

Inter-American Friendship through the Schools

THE U.S. Office of Education has issued as Bulletin No. 10, 1941, "Inter-American Friendship through the Schools", a report based upon a research study conducted by the Office of Education for the specific purpose of ascertaining the extent of inter-American studies that are already a part of the school curriculum. The bulletin is based largely on the replies of school administrators to a questionnaire, and the central purpose of the investigation was to discover the opportunities of learning which the curriculum presents and the patterns of teaching relative to the development of inter-American understanding that are to be found in the elementary and secondary schools of the United States. From the 6,623 administrators to whom the questionnaire was sent, 2,471 replies were received in time to be tabulated for the report. Of these, 671 stated that Spanish was being taught, and one half of the schools reporting indicated that, although they did not offer Spanish, they provided a study of the other Americas in various courses given in English. No study relating to the other American republics in Spanish or in English was reported by 521 of the schools.

Dinosaur Find at Washington, D.C.

IT is stated by Science Service, of Washington, D.C., that the broken upper part of a saurian thigh-bone has been found in a new excavation being made for the D.C. filtration plant at Washington. The bone was identified as belonging to one of the sauropod group of dinosaurs by Dr. C. W. Gilmore, curator of vertebrate palæontology at the U.S. National Museum. Two finds of dinosaur bones have previously been made in Washington; they were of rather fragmentary fossils. Judging from the size of the present find, Dr. Gilmore said, the original animal was about ten feet high at the hips and fifty or sixty feet long, weighing approximately ten tons. Apparently, from the geological evidence, it was trapped in a small pond or mudhole and so perished. These creatures lived during the Cretaceous, about 150 million years ago.

Restoration of Historic Monuments in the U.S.S.R.

A SPECIAL committee for the registration and protection of architectural relics and historic monuments has been set up by the Soviet Government. It consists of leading members of the Academy of Sciences and architects, headed by Igor Grabar, a Stalin prize-winner. One duty of this committee will be to establish the amount and nature of the destruction and damage caused by the Germans in occupied districts and, where restoration is at all possible, to supervise the work.

Cosmic Ray Research

AN expedition of the Academy of Sciences of the U.S.S.R., led by Prof. A. I. Alikhanov, has arrived in Erevan, the capital of Soviet Armenia, to study cosmic rays. It will be in the field for about six weeks, making observations at the high-altitude meteorological station in the Alpaz mountains.

Recent Earthquakes

A SEVERE earthquake shook the towns of Santiago and Valparaiso and the region between the towns at about 1.30 a.m. (local time) on June 29. The *Intendencia*, headquarters of the Provincial Government, and other buildings were damaged in Valparaiso. Property was also damaged in Santiago, and for a while the electricity supply was interrupted. Thirty-seven people were reported injured. The earthquake was probably the most severe in Chile since 1927, when Talca and Concepcion were destroyed.

A moderate earthquake shook the town of Karachi at 8.30 a.m. approximately on the morning of July 3. No damage has been reported.

Free German Institute in London

A FREE German Institute is being founded by the science section of the Free German League of Culture in Great Britain. The aims of the Institute are: (i) to uphold and develop the valuable traditions of the Free German research work and teaching; (ii) to provide for interchange of opinion between Free German men of science and those of the United Nations; (iii) to strengthen the German refugee youth in the spirit of international understanding, and to enable them to help in re-shaping Germany's cultural life after the destruction of Nazism. The opening session will be held on July 17 at 7.30 p.m. at the Everyman Theatre, when an address will be given by Dr. Joseph Needham. Further particulars of the movement can be obtained from the secretary, Free German League of Culture, 36 Upper Park Road, London, N.W.3.

Announcements

THE honorary degree of D.Litt of the University of Oxford has been conferred on Commander Claude Schaeffer, of the Free French Navy, who is deputy curator of the Musée des Antiquités Nationales at Saint-Germain, and conducted important archæological excavations at Ras Shamra in North Syria.

A WHOLE-DAY conference is being arranged by the Nutrition Society, jointly with the Food Group of the Society of Chemical Industry, on "Dehydration of Foods and the Effect on their Nutritional Value", to be held at the British Medical Association House, London, on July 25. A later meeting, probably at the end of October, will deal with "Trace Elements in Nutrition". Further particulars of meetings can be had from the honorary secretary of the Nutrition Society, Dr. Leslie Harris, Nutritional Laboratory, Milton Road, Cambridge.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Raman's Theory of Specific Heat of Crystals

A DESCRIPTIVE article by Dr. W. H. George surveying some recent papers by Sir C. V. Raman and his school[1,2] having appeared in NATURE of May 16, we wish to make a few comments. A detailed criticism of Raman's paper will appear elsewhere.

(1) Raman rejects the result of lattice theory that the vibrational spectrum of a crystal consists of several (three or more) practically continuous branches, and contends instead that it consists of a few discrete vibrations. He bases this assumption on the observation that only a few sharp lines appear in optical absorption and scattering.

Lattice dynamics explains this fact by the optical selection rules: only those mechanical vibrations react with light waves which are in phase in a region of the order of a wave-length. As the wave-lengths concerned are long compared with the lattice constant, this selection rule restricts optical resonance to a practically monochromatic region in each branch of the spectrum. Hence the optical facts provide no argument against lattice dynamics.

(2) Raman[1] calculates the specific heat by superposing a few Einstein functions according to his interpretation of the spectrum. But in the majority of cases treated by his collaborators (Norris, Dayal, Anand, Venkateswaran[2]), these vibrations are not taken from optical data but chosen in such a way as to obtain a fair agreement for the specific heat. These calculations prove therefore only the well-known fact that a few Einstein functions can be fitted to the specific heat data of a solid. Nernst and Lindemann[3] showed in 1911 that even two frequencies in the fixed ratio 1 : 2 were quite sufficient for many substances. Born[4] has shown further that the higher branches of the vibrational spectrum cover a small frequency interval and can be replaced, for calculations on the specific heat, by a monochromatic vibration. But this is an approximation, and the fundamental fact that a system of $N \simeq 10^{23}$ particles has $3N$ modes of vibration cannot be explained away.

In the case of rock salt an attempt is made (Venkateswaran[2]) to relate some of the vibrations to peaks in the Raman spectrum; but strangely enough these were considered to be octaves of the required lattice vibrations. The frequencies of sylvine are all taken to be 0·78 of those of rock salt. All these assumptions are quite arbitrary and do not lead to results better than those given by previous calculations (see accompanying table).

(3) Raman's rejection of Debye's theory is based mainly on the alleged better agreement of Raman's formulæ with observation. But Debye's formula contains only one frequency and that not arbitrary, but expressible in terms of the elastic constants. It is very likely the best one-constant theory possible and serves remarkably well for monatomic substances. Its deficiencies appear at very low temperatures where particular phenomena are observed (for example, an increase in the value of the Debye parameter for NaCl with falling temperature). These have been satisfactorily explained by the rigorous lattice dynamics[5,6].

As an example, the experimental specific heat values found for rock salt by Clusius and Perlick[7] are tabulated below, together with the values calculated by Kellermann[8]; the last column is taken from a table calculated by Venkateswaran[2] applying Raman's theory.

$T°$ K.	C_v (expt.)	C_v (lat. theory)	C_v (Raman's theory)
10	0·0326	0·0328	0·036
20	0·310	0·317	0·28
30	1·150	1·154	0·96
40	2·380	2·380	2·04

(4) Raman rejects lattice dynamics because it uses the postulate of the 'cyclic lattice' for the calculation of the vibrations. Raman considers this an arbitrary assumption which leads to wrong results. In fact it is a reasonable method of approximation against which no mathematician has ever raised a doubt. The rigorous solution was known for the monatomic linear lattice, where it leads to the same results; in order to refute Raman's objections the correct solution for a di-atomic linear lattice has been worked out[9], and again complete agreement with the cyclic method was found. It must further be remembered that most of the well-confirmed results of the quantum theory of electrons in metals (electric conductivity, metal optics, etc.) are based on the cyclic method and can be considered as confirmations of it.

(5) Raman considers the frequencies of a lattice to a first approximation as those of the inner vibration of the single cell; but he suggests that there is an influence of the neighbouring cells which can be taken into account. This is in fact a reasonable and well-known way[4] of approximating to the higher (optical) branches; but it fails completely for the lower (acoustical) branches, and is therefore useless for monatomic lattices (all metals) where there are no higher branches, and, more generally, for substances (like the alkali halides) where it is not possible to consider the atoms in a cell as bound together with stronger forces than those connecting them to the neighbouring cells. It is in these cases that good confirmation is obtained for lattice dynamics in calculating the lattice energy, and elastic, optical, piezo-electric and other constants. All this would have to be abandoned if Raman's ideas were correct.

(6) Raman's theory has been devised to justify his interpretation of the diffuse X-ray scattering. It has been shown[9] that this interpretation is in contradiction with observations and with well-established theory, and that lattice dynamics accounts for the facts more satisfactorily. The diffuse X-ray spots are nothing but photographic images of the quasi-continuous spectrum derived from the lattice theory which Raman attacks.

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[1] Raman, Sir C. V., *Proc. Ind. Acad. Sci.*, A, **14**, 459 (1941).
[2] *Proc. Ind. Acad. Sci.*, A, **14**, 473-506 (1941).
[3] *Z. Electrochem.*, **17**, 817 (1911).
[4] "Atomtheorie des festen Zustandes" (Berlin, 1923).
[5] Blackman, M., *Proc. Roy. Soc.*, A, **159**, 416 (1937).
[6] Kellerman, W., *Proc. Roy. Soc.*, A, **178**, 17 (1941).
[7] See Keesom, W. H., *Phys. Z.*, **35**, 939 (1934).
[8] Born, M., *Proc. Phys. Soc.*, in the press.
[9] Born, M., Lonsdale, K., and Smith, H., NATURE, **149**, 402 (1942).

Absorption Spectra of 3-4 Benzpyrene

EVIDENCE has been given[1] that benzpyrene emits various fluorescence spectra according to its physical state. Molecular benzpyrene, the monoclinic, the orthorhombic crystallized modification and the colloidal suspension in water fluoresce violet, green, blue and yellow respectively. The fluorescence spectrum of dissolved benzpyrene is unchanged in various solvents except for slight displacements of the entire group of bands[2]. We have now studied the absorption spectra with a low-voltage projection lamp as a light source for a continuous spectrum, which restricted the observation to the radiation transmitted by glass. It was found that the first broad absorption band of dissolved benzpyrene[3] has three components, α, β, γ, at 383, 380 and 377 mμ respectively in hexane (Fig. 1,*a*). They are of almost the same strength, but they behave differently in various solvents. While the α-component persists as the maximum, β and γ fuse and disappear more or less by polar effects due to the solvent.

The absorption spectrum of the blue fluorescing orthorhombic modification of solid benzpyrene (Fig. 1,*b*) is entirely different from that of the dissolved hydrocarbon. It shows a broad absorption band between 415 and 425 mμ which is accompanied by three narrower bands at 405–410, 392–396 and 384–387 mμ respectively. In order to delay the spontaneous transformation[1] of the metastable orthorhombic into the stable monoclinic crystals, very thin crystal films were prepared by evaporating a benzene solution of benzpyrene on cover glasses. A pile of six such films absorbs strongly enough to render visible the long wave-length portion of the absorption spectrum.

The monoclinic needles which fluoresce green, and their colloidal yellow fluorescent suspension in water, cannot easily be prepared in a state which is suitable for absorption spectroscopy. An indirect method was devised which allowed this difficulty to be overcome. It is based on the observation of Bowen and Sawtell[4] that the fluorescence efficiency of a fluorescent solution is usually independent of the wave-length of the exciting radiation within wide limits. Hence, if a continuous spectrum is focused on to the fluorescent substance in a layer so thin that the absorption is *feeble*, the absorption spectrum appears as fluorescent light. This can be recorded by a photographic plate if a thin film filter is placed between the fluorescent layer and the photographic emulsion, which completely absorbs the exciting short wave-length radiation and transmits the fluorescent light. Henri and Wurmser[5], by this technique, separated from a discontinuous spectrum the radiations which excite the fluorescence. Fig. 2 shows positives of 'fluorograms' of molecularly dissolved benzpyrene in Canada balsam (*a*), of the orthorhombic form as a single layer of sparsely distributed thin crystal squares of about 5 μ side under water (*b*), of the monoclinic form as a loose mosaic of microscopical crystal leaves on a cover glass (*c*) and of a colloidal suspension of benzpyrene in water (*d*). The fluorograms *a* and *b* repeat as luminous bands the dark bands of Fig. 1,*a* and 1,*b* although in a different strength. The same flat maxima of Fig. 2,*c* and 2,*d* at about 425 mμ establish the fact that the particles of the colloidal suspension are ultra-microscopical monoclinic crystals.

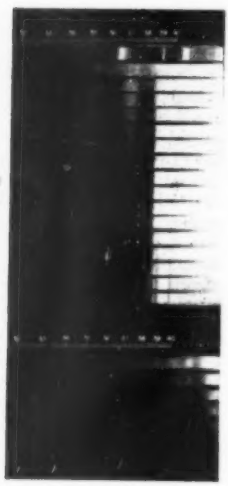

Fig. 1.
ABSORPTION SPECTROGRAMS (POSITIVES) OF BENZPYRENE.
(*a*) Dissolved in hexane, 1 : 100000 : layers 2–32 mm. in thickness.
(*b*) Pile of 6 orthorhombic crystal films. Increasing exposures.

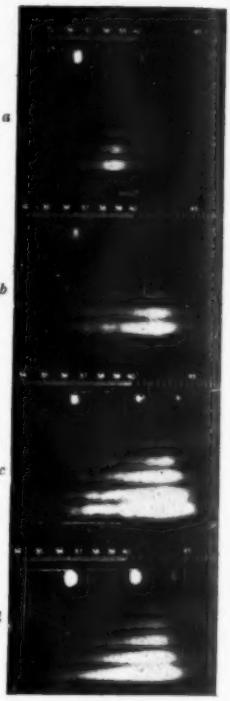

Fig. 2.
FLUOROGRAMS (POSITIVES) OF BENZPYRENE. INCREASING EXPOSURES.
(*a*) Dissolved in Canada balsam.
(*b*) Orthorhombic crystals in water.
(*c*) Mosaic of monoclinic crystals on glass.
(*d*) Colloidal suspension in water.

The method permits of recording—at the present stage, qualitatively—the absorption spectra of systems which are not suitable for the usual spectroscopic methods. This applies to colloid suspensions, microcrystals, and generally to mixed systems with a fluorescent component which must not or cannot be separated. Experiments are in progress to study the absorption spectra of biological fluorescent specimens in their original state, especially in connexion with problems of cancer research. It should be noted that a 'fluorogram' records the absorption spectrum of that component of a mixed fluorescent system (for example, a solid solution) which actually absorbs the light, irrespective of which component actually fluoresces. Thus colloidal suspensions of blue fluorescent pure anthracene and of green fluorescent anthracene which contains naphthacene both gave the fluorogram of anthracene only.

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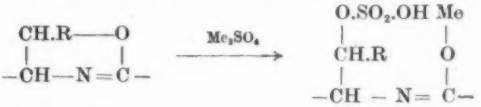
[1] Weigert, F., and Mottram, J. C., NATURE, **145**, 985 (1940).
[2] Chalmers, F. G., *Biochem. J.*, **32**, 271 (1938).
[3] Mayneord, W. V., and Roe, Edna M. F., *Proc. Roy. Soc.*, A, **152**, 323 (1935).
[4] Bowen, E. J., and Sawtell, J. W., *Trans. Faraday Soc.*, **33**, 1425 (1937).
[5] Henri, V., and Wurmser, R., *J. de Phys.* (6), **8**. 289 (1927).

Oxazoline and Thiazoline Rings in Proteins

A STUDY of the *O*-methylation of wool and silk with methyl bromide and methyl sulphate showed the extent of methylation could not be entirely accounted for as esterification of free carboxyl groups and we suggested that methylation of activated peptide linkages also took place[1]. We have now obtained evidence suggesting the activated peptide linkages are possibly those which have undergone condensation with the side-chains of β-hydroxy acids, for example, serine and threonine. By this condensation, oxazoline rings may arise, which Bergmann and Miekeley[2], from studies of the reactions of *O*- and *N*-benzoylserine, have considered possible constituents of proteins.



We have now observed, in agreement with the above mechanism of methylation, that sulphuric acid is held firmly by wool methylated with methyl sulphate, and that methyl bromide, which would be less likely to open the oxazoline ring, gives less peptide methylation. We have also found that both acetyl and methyl groups can be introduced into wool, silk and collagen by the combined action of methyl alcohol and acetic anhydride. With wool, the extent of this new methylation is quantitatively similar to the peptide methylation obtained with methyl sulphate but not with either methyl bromide or iodide. For example, methyl sulphate introduced into different samples of the same wool 1·66 per cent CH_3; methyl bromide/iodide, 1·02 per cent CH_3; while acetic anhydride and methyl alcohol introduced 0·63 per cent CH_3. Hence, methyl sulphate introduced 0·64 per cent CH_3 to enolized peptide linkages as against 0·63 per cent CH_3 introduced by acetic anhydride and methyl alcohol. Methyl *p*-toluenesulphonate in methyl alcohol containing anhydrous potassium carbonate introduced 1·39 per cent CH_3 into this wool. Qualitative tests showed that some methylation of the tyrosine-hydroxyl may have occurred, but it is probable that cleavage of the oxazoline ring took place and both the peptide hydroxyl and the hydroxyl of the β-hydroxy acid were methylated.

Other evidence we have obtained suggests that free cysteine side-chains in reduced wool may form thiazoline rings in the same manner as serine side-chains form oxazoline rings, a possibility to which Linderstrøm-Lang and Jacobsen[3] have directed attention in their study of the reactions of methylthiazoline. Thus wool after maximum reduction with thioglycollic acid at *p*H 5[4] gives hydrolysates containing about half the original cystine-S as cysteine-S[5], but contrary to the findings of Harris and co-workers[4], we find that all the thiol groups in the reduced wool will not react with methylene iodide. After exposure to methylene iodide in buffer of *p*H 5, reduced wool ceases to give a nitroprusside reaction, but nevertheless, when hydrolysed yields 0·7 per cent of cysteine-S. A somewhat larger percentage of cysteine-S of the reduced wool fails to react with methylene iodide in buffer of *p*H 8. When oxygen is passed into buffer of *p*H 5 in which reduced wool is immersed, the cysteine-S is oxidized to cystine-S. If, however, the *p*H of the buffer is raised to 8, then about 0·7 per cent cysteine-S of the wool remains unoxidized, and again fails to give a nitroprusside reaction, unless guanidine is added. On the other hand, when the buffer of *p*H 8 contains guanidine, all the cysteine-S of the wool is oxidized to cystine-S. These results suggest that some of the cysteine side-chains form thiazoline rings, masking the thiol groups, which become available for reaction only to certain reagents when other experimental conditions are favourable.

Our observations have an obvious bearing on the unmasking of thiol groups when sulphur-containing proteins are denatured[6] and the increase in free reactive thiol groups which occurs when guanidine hydrochloride is added to solutions of myosin[7] and albumin[8].

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[1] Blackburn, S., Carter, E. G. H., and Phillips, H., *Biochem. J.*, **35**, 627 (1941).
[2] Bergmann, M., and Miekeley, A., *Z. Physiol. Chem.*, **140**, 128 (1924).
[3] Linderstrøm-Lang, K., and Jacobsen, C. F., *J. Biol. Chem.*, **137**, 443 (1941).
[4] Patterson, W. I., Geiger, W. B., Mizell, L. R., and Harris, M., *J. Res. Nat. Bur. Stand., Wash.*, **27**, 29 (1941).
[5] Middlebrook, W. R., and Phillips, H., *Biochem. J.* (in press).
[6] Hopkins, F. G., NATURE, **126**, 328, 383 (1930).
[7] Mirsky, A. E., *J. Gen. Physiol.*, **19**, 559 (1936).
[8] Greenstein, J. P., *J. Biol. Chem.*, **125**, 501 (1938).

Optical Projection as an Aid in Studying Plane Spiral Coiling of Small Fossil Lamellibranchs

THE use of optical projection in certain screw-gauges[1] and pivot-wear meters[2] suggested methods for examining the kind and degree of variation shown by plane spiral coiling in a group of small and well-preserved lamellibranchs (*Gryphæa incurva* (Sow.)) when researches upon these variations were extended[3] in this Department recently. Identical methods proved applicable to the study of small ammonites and other shells, whether fossil or recent, provided they were coiled in a plane spiral.

It was found that an accurate lantern-slide projector gave on a suitable screen a sharply defined silhouette of any lamellibranch up to 60 mm. in diameter when the fossil was held centrally in the lantern-slide carrier on a wax or 'Plasticine' pedestal, with the plane of coiling of the shell coincident with the focal plane of the projecting lens system.

For each specimen, by appropriately altering the distance between lantern and screen and sharply focusing its silhouette, a magnified but negligibly distorted image of constant diameter was obtained, the profile of which could be traced with a pencil on a sheet of opaque white paper, or tracing paper, attached to the screen.

Using opaque recording paper, comparisons between groups of these profiles were then facilitated by cutting along the profile outlines and superposing the 'cores' so separated from the sheets. With profiles drawn on tracing paper, the superposition of chosen profiles on an illuminated tracing desk rendered their comparison even simpler than with opaque paper.

Alternatively, the profile of a particular lamellibranch was directly compared with one of several

accurately plotted spirals by adjusting the diameter and orientation of its projected silhouette on an opaque white paper screen which bore a group of these curves, drawn from a common centre in black ink. The rapidity of this method was outweighed to some extent by its failure to provide the more permanent records of profiles afforded by the other two methods.

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[1] Pollard, A. F. C., *Eng. Inspection*, Feb. 14, 1935, pp. 79–113.
[2] Stott, V., Report *Nat. Phy. Lab.*, 1925, p. 151.
[3] MacLennan, R. M., and Trueman, A. E., *Proc. Roy. Soc. Edin.*, **61**, Pt. 2, 212–32 (1942).

Death of St. Peter's Fish in Lake Huleh, Palestine

PALESTINE has been having some extremely cold weather and the past winter was probably one of the severest in recent years. Snow in Jerusalem and on the hills caused delight and amazement to much of the human population, but the bitter cold caused havoc and death among some of the fish in the north of the country.

In Lake Huleh, very large numbers of fish died and were eagerly collected by the local inhabitants. Altogether in three days early in January, more than 30 tons of fish were taken dead from the lake, which is a large number when it is realized that the total annual catch from the lake is only about 80 tons, of which 60 tons belong to the family Cichlidæ. It is, of course, impossible to estimate the amount of fish that died and which could not be collected, but it must certainly be large. Fish in Lake Huleh die whenever there is a very cold winter, but not on a large scale as on this occasion. The last time that appreciable quantities were killed was in 1921, but a few died of cold so recently as 1935. Usually in winter a large proportion of the fish congregate in the small rivers running into the lake and in the swampy areas around the shores. In these waters the temperature is higher than in the main part of the lake and the fish are protected from the floods of very cold water coming down from Mount Hermon.

In the past it was the custom to cut the reeds to keep the river mouths clear and so help the fish escape from the lake. In recent years, however, the reeds have not been cleared, and the river mouths are partially blocked, making it more difficult for the fish to enter. This factor may well have increased the destruction of the fish during the last cold spell. Among the dead only the family Cichlidæ, particularly the members of the genus Tilapia or St. Peter's fish, were represented, the remaining families, Cyprinidæ and Clariidæ, being apparently more hardy and able to withstand the cold. The European carp which have recently been introduced into the lake also came to no harm. Strange as it may seem, it was only the large Tilapia that were killed, though it is possible that the smaller specimens were in deeper water and the dead were not collected.

The lowest temperature recorded from the lake was 9° C., near the eastern shore. This does not seem very low, but probably the rate at which the temperature fell was more important in affecting the fish than the actual temperature. Since Lake Huleh is a shallow basin, fed by the Jordan River and by many small streams running down from Mount Hermon, and since all mountains in this region were thickly covered with snow at the time, it is probable that the water coming down was extremely cold and capable of causing local and very sudden drops in temperature in the lake, far below the 9° C. recorded.

The death of so many fish caused consternation in the country and much speculation as to whether the stock has been seriously damaged. Unfortunately it is impossible to know what proportion of the stock has been killed, for it is extremely difficult to estimate the number of Tilapia in the lake. The facts that the water is full of weeds and that much of the shore is swampy makes fishing difficult, and I do not believe that the lake is normally being fished as intensively as it should. A weight of 30 tons, or an amount equal to half the annual catch, of Tilapia is therefore probably not a large proportion of the stock as a whole. Also as only the larger fish appear to be affected and as there are huge areas of swamps, particularly in the great papyrus zone in the north, where the fish can take refuge, the damage is probably not so serious as at first appeared. Similar mass deaths must have occurred in the past during exceptionally cold years, but the lake is still well stocked and there is no evidence to suggest that the size of the stock is being reduced either by the rigours of the climate or by too intensive fishing—would that the same could be said of the depleted Sea of Galilee.

In actual fact it probably would not be a serious matter if the stock in Lake Huleh was damaged, for if the basin is likely to be drained in future, as has often been suggested, a large proportion of the fish will be destroyed in any case. Better that the lake should yield up some of its wealth now than in the future, when the need for locally produced food should not be so urgent.

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Russian-English Technical Dictionary

THERE is an urgent demand at the present time for an up-to-date Russian-English dictionary of scientific and technical terms. It is known that a number of Russian-English glossaries of specific terms have been compiled by various scientific institutions and individuals, and it is thought that it would be extremely helpful to scientific workers and technical translators if copies of these glossaries could be collected together and placed in the Science Library in London, where one complete set could be consulted.

Will, therefore, any institution or individual who has compiled a glossary of Russian scientific or technical terms, whether printed or in manuscript, please send a copy to the Secretary, Anglo-Soviet Scientific Collaboration Sub-Committee, The British Council, 3 Hanover Street, W.1, who will collect these for the Science Library.

It is hoped at a later stage to compile a large dictionary, but the immediate aim is to collect the different glossaries in one place where they can be consulted. Each glossary will be known by the name of its compiler.

E. J. RUSSELL
Chairman,
Anglo-Soviet Scientific
Collaboration Sub-Committee.

A RELATIVE CENSUS METHOD FOR BROWN RATS (*RATTUS NORVEGICUS*)

By DENNIS CHITTY

Bureau of Animal Population, Oxford University

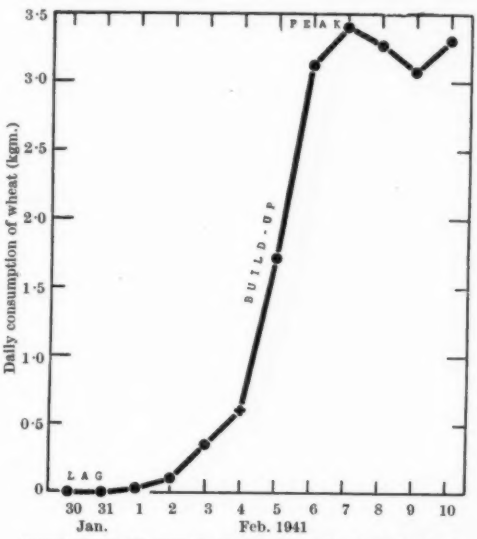
A USEFUL summary of census methods for mammals has been given by Dice[1]. Apart from those which involve killing the animals the following types have been used: counts of droppings, tracks, homes, or the animals themselves; live trapping followed by marking and releasing. Live census methods for rats have not, except in ship deratization work, been well developed along these or other lines. *Droppings* are the most reliable signs used by inspectors on board ship[2]; and their estimates of infestation usually check very closely with numbers found dead after fumigation[3]. The operation, however, is a highly skilled one, and since allowance must be made for the type of food and rate of desiccation of the droppings, probably cannot well be applied elsewhere. *Tracks* and runways in mud, dust, snow, etc., show rat distribution but give little indication of numbers. A white powder such as plaster-of-Paris is useful for showing up footprints. *Homes.* In habitats such as hedge banks a count of holes may be made; but in buildings the number is seldom related to the density of the rats. Nests of *Rattus rattus* subspecies can be seen in the trees in Hawaii[4,5] but nests of brown rats are not as a rule easily found. *Brown rats themselves* are largely nocturnal, and no representative fraction of the population is likely to be seen (on ships not more than one in twenty)[2] except by destruction of the habitat or by bolting the rats with gas or ferrets. (The method is not good in premises such as shops.) *Live trapping*, marking and releasing has been carried out at this Bureau, but involves a good deal of work and technical difficulty. *Other signs* of the presence of rats include their odour, damage to food and structures, the black, oily smear left along runways and an occasional dead rat[2].

Prebaiting for one or more days is a well-known system of rat control, but usually only small amounts of prebait are laid before the same food is given with poison added. We have termed this system 'token' as distinct from 'surplus' prebaiting which, so far as is known, has only been used before in Hawaii. Here Pemberton[6] and Doty[6] discovered that when prebait was given in excess the take increased daily for about a week as more and more rats were attracted (chiefly *Rattus norvegicus* and *R. hawaiiensis*). By mapping the distribution and amount of poison bait afterwards eaten, Doty showed the relative distribution of rats in the cane fields. In its essential features this author had already described a type of feeding behaviour discovered independently a few years later at Oxford.

Surplus baiting has been developed here as an essential part of rodent control research for the Agricultural Research Council, in the course of which it has been necessary to obtain accurate field measurements of relative population density. Wild brown rats are offered more wheat than they can eat, and, as a rule, their maximum daily consumption is used as the index of relative abundance. Wheat, which is eaten with little waste, has provided a standard medium without which these experimental results could not have been obtained. Oats and barley are less suitable as they are husked, and meals are more subject to the effects of weather and are bulkier to carry.

Fig. 1 is a typical curve showing consumption of wheat by brown rats at a prebaiting point on a rubbish dump. A 'lag', sometimes up to twelve days, may be expected before the start of feeding if the prebait is put under newly placed cover (here, an old tin trunk was used). This delay is chiefly due to rats' intense suspicion of alterations to their environment. 'Build-up': the number of prebaited rats increases for several days and a 'peak' rate of feeding is reached which is seldom exceeded unless the colony is being reinforced by breeding or immigration.

Storing. Certain types of food are stored by rats, but we have no evidence that this has happened when wheat is used as prebait, though mouthfuls may be taken away and eaten nearby. Even at places where baiting was carried on for weeks at a time no stores were ever found, and frequently after



CONSUMPTION OF WHEAT BY BROWN RATS AT A PREBAIT STATION PLACED ON JANUARY 29, 1941, ON A RUBBISH DUMP. DAILY CONSUMPTION IN GM. AS FOLLOWS: 0, 0, 30, 108, 350, 600 (NO SURPLUS LEFT), 1,710, 3,127, 3,402, 3,270, 3,077, 3,306.

the supply had been reduced for a day the take was temporarily increased when surplus was again provided. This and other evidence of hunger shows that no important food reserves had been collected. Also if the bait is changed to a non-portable type such as wheatmeal the daily consumption is about the same.

Fraction of population prebaited. From the fact that a whole population can be poisoned from properly placed stations it is concluded that all the animals can be prebaited.

Proportion of prebait in total diet. This no doubt varies from place to place, and temporary drops in take after the build-up are probably due to other foods being discovered; but as a rule the fluctuations are surprisingly small. In a few cases more attractive forms of prebait must be used than wheat; but except where large amounts of food are stored without protection, as in ricks and certain warehouses, no difficulty is found in getting rats to take the bulk

of their food from stations conveniently placed and regularly supplied with wheat. For example, in a certain restaurant extensive damage was being done until, after surplus baiting was started, the rats confined their attention almost entirely to the wheat.

Wild rats' consumption of prebait (per kgm. body weight) is being compared in different environments and with the amount eaten in captivity. A number of rats are trapped alive from a prebaited population and the subsequent drop in take is attributed to their removal. The rats are weighed, sexed and fed for a few days in a large outdoor cage. Experiments in progress may make it possible to convert the present relative census method into one giving the approximate number of rats.

Disturbance. The provision of unlimited food may sometimes alter existing conditions, and immigrants will be attracted if the baiting points are not, as they should be, spaced out to cover the whole colony at once. A fluctuating food supply is frequent among rat colonies and short periods of prebaiting seem unlikely to produce results that will invalidate the census or disturb the population. If token baiting is carried out during the build-up period, a surplus need only be provided for two or three days afterwards.

Specificity of the method. Animals other than rats and mice (the latter, when present at all, eat relatively little) can be kept from the bait by providing cover such as a large box with a 3-in. diameter hole; but it is most convenient to use small containers of a standard design developed by the Bureau.

Summary. A method of relative census for brown rats consists of measuring the feeding capacity of the population. It is simple to carry out, applicable in a wide variety of habitats and involves a minimum of interference with the rats. No other suitable technique is known that does not involve killing the rats. The method should be applicable to other populations which consist of only one species of small mammal.

[1] Dice, L. R., *J. Wildlife Management*, **5**, 398 (1941).
[2] Williams, C. L., *Publ. Hlth. Rep. Wash.*, **47**, 765 (1932).
[3] Peirce, E. R., *Med. Off.*, **43**, 222 (1930).
[4] Dopmeyer, A. L., *Publ. Hlth. Rep. Wash.*, **51**, 1533 (1936).
[5] Pemberton, C. E., Bull. Hawaii. Sug. Ass. Ent. Ser., No. 17, 1-46 (1925).
[6] Doty, R. E., *Hawaii. Plant. Rec.*, **42**, 39 (1938).

FUTURE OF TRANSOCEANIC TELEPHONY*

TELEPHONY was born from telegraphy by an expansion of the band of frequencies employed in the electrical transmission of intelligence. More recently, further expansion has produced improvement of quality of transmitted speech and an increase of the number of simultaneously transmitted conversations. To-day, speech can be transmitted overland perfectly for any distance and with hundreds of conversations at once over a single coaxial line.

Telegraphy takes a certain band-width measured in cycles per second for a particular speed of signalling measured in words per minute. A telegraph machine printing 60 words a minute needs about 100 cycles and intelligible telephone communication requires about 1,000 cycles. 3,000 cycles for commercial telephony is now a reasonable engineering standard although it does not provide for perfect speech transmission. Speech frequencies cover about 8,000 cycles, though frequencies above 4,000 contribute little to intelligibility or quality. The range of the normal human ear is about 15,000 cycles and perfect transmission of music requires that band-width. Little is lost, however, if the music is limited to 8,000 cycles. Television requires from 20,000 cycles for a recognizable human face to 20 millions or more for vision as well defined as in standard cinema practice, but in present commercial practice the band-width is limited to about 3 million cycles.

The available frequency range of a transmission line of given band-width can be allocated to telegraphy, telephony or television at will. Twenty printing telegraph channels with adequate separation cost in frequencies about as much as one ordinary telephone channel, but for a television channel the equivalent, in frequencies, is 1,000 telephone or 20,000 printing telegraph channels.

A major advance in trans-Atlantic cable telegraphy ensued with the introduction of the permalloy-loaded cable in 1924, having a band-width many times that of corresponding non-loaded cables. The fastest loaded trans-Atlantic cable has an effective frequency band of more than 100 c./s. and can carry four times as much traffic as a non-loaded cable of the same size and length. Development of permalloy loading led to the manufacture of a 20-mile section of this type of cable in 1930, and while all the measurements in the laboratory, at sea, and from shore confirmed the technical soundness of the proposal to install such a cable, the project was postponed temporarily because of general business depression and later, indefinitely, because of the improvements in trans-Atlantic radio communication.

In the development of radio for transoceanic communication, only two isolated ranges of the band spectrum are utilized, each of which is comparatively narrow. The low-frequency range is a band some tens of kilocycles wide with a top of about 100 kc. In the 1920's the band of frequencies useful for long distances was widened several hundredfold by the discovery of short-wave transmission at frequencies in the range of 3–30 mc. This put transoceanic radio communication on its present world-wide basis. Short waves contributed also to the demand for service, since the apparatus required for short-wave circuits cost less than that for long waves.

The trans-Atlantic telephone started in the relatively cramped long-wave band and then moved into the freer region of the short-wave range. Speech was first sent across the oceans from Arlington, Va., to Paris and to Honolulu in 1915. For its accomplishment the first high-power vacuum tubes and the first master-oscillator, power-amplifier tube transmitter were evolved. In the long-wave range and for trans-Atlantic distances, radio is seriously limited in respect of the high noise-level, particularly in summer, due to thunderstorms in northern latitudes, and of the weakness of the received signals during the sunset and sunrise periods. The development of the water-cooled, high-power vacuum tube made possible high-power amplifiers to deliver tens of kilowatts needed to lift the signal higher above the level of atmospheric noise. The influence of static was

* Substance of the thirty-third Kelvin Lecture delivered before the Institution of Electrical Engineers by Dr. Oliver E. Buckley, of the Bell Telephone Laboratories, on April 23.

further reduced by the use of directive receiving antennas. Additional improvement was provided by the technique of single-sideband transmission first used on wires. These and other developments assured fairly reliable telephone connexions and in 1927 public service was opened jointly by the General Post Office and the American Telephone and Telegraph Co. The carrier frequency was 60 kc./s., corresponding to a wave-length of 5,000 m.

The opening of the first trans-Atlantic short-wave telephone circuit in 1928 followed close on the long-wave circuit, and was followed in turn by additional short-wave circuits in 1929. Opportunities for greatly improving short-wave transmission then appeared so that the project of the second long-wave circuit was deferred and, later, postponed indefinitely. More recently, experiments have demonstrated the feasibility of transmitting two channels at different frequencies using the same transmitting equipment.

Short-wave radio gives less attenuation, lower noise and a wider frequency band in which to operate compared to long waves for transoceanic service. For a radio-telephone connexion between the United States and England the cost of short waves for an approximately comparable quality of service is about one half that of long waves. The wider band provides an opportunity for the service to expand, and it is hundreds of times wider than the long-wave band. These advantages have been reflected in the rapid growth of short-wave transoceanic telephony; at the beginning of 1939 there were in service throughout the world about 170 important long-distance short-wave telephone circuits, of which five were in regular use between the United States and Europe. There has grown up also a host of short-wave broadcasting channels, the better co-ordination of which had yet to be worked out.

Short-wave transmission, however, is susceptible to periodical interruption, particularly around the maxima of the eleven-year sunspot cycle. Short waves are also affected adversely by various types of signal distortion as the received signal is usually made up of several components which have travelled over different paths. Sometimes these paths all lie along the same great circle but involve different numbers of reflexions between the earth and the Heaviside layer. Sometimes signal components arrive over other than the great-circle path. Occasionally components travel along the longer of the two great-circle paths between the transmitter and receiver, or even clear around the world, producing 'round-the-world echo'. Interference between waves arriving over different paths results at times in 'general fading' caused by variations in the level of the whole band and at other times in 'selective fading' in which portions of the speech band are affected differently.

Single-sideband transmission has, however, helped in eliminating the periodical fading out of the carrier signal which particularly gives rise to a harsh, grating received speech. The multiple-unit steerable antenna (MUSA) recently developed in Bell Telephone Laboratories reduces selective fading by combining signals arriving over different paths or by eliminating all signals except those arriving over one path. Additional antenna directivity makes possible operation in periods of reduced signal strength, though it does not eliminate circuit interruptions at times of very severe disturbance. Single-sideband transmission and the 'MUSA' are now in regular use on the New York–London telephone circuits.

The most significant recent development in land-line telephony is that of broad-band transmission by carrier methods over open wires, cables and coaxial conductors of a considerable group of telephone bands on closely spaced channels. Over open-wire lines and over pairs in lead-covered cables, 12 telephone bands spaced at 4,000-cycle intervals are commonly transmitted in a group occupying a total band-width of 48,000 cycles. With coaxial conductors the band has been increased to 2 million cycles, giving frequency space for some 500 telephone channels, and it may be expanded still further.

The application of broad-band methods to trans-oceanic radio telephony are likely. Commercial success has already been achieved with small numbers of channels in the Holland–East Indies and the United States–England single-sideband systems. By applying the principles of negative feedback, Bell Laboratories engineers have developed a short-wave transmitting amplifier of 200 kw. capable of handling twelve or more closely spaced telephone channels.

When the sun is over the mid-Atlantic in summer there is available a useful band about 4 mc. wide, in the 14–18 mc. range. These short waves cannot be counted upon, however, to be duplicated very often for simultaneous use at different locations throughout the world. The available 4 mc. band must be divided therefore to meet a large number of requirements, and public service telephony across the Atlantic deserves something like a tenth of the total facilities in this band. This would mean an allocation of 400 kc. or 100 one-way telephone channels, yielding 50 or more two-way circuits realizable under the natural limitations of the medium and the other requirements placed upon it.

We can anticipate with confidence a great growth of trans-Atlantic telephone traffic, but in proportion as the demands for service grow and we come closer to the realization of the ultimate physical possibilities, the more serious becomes the threat of interruption to this service by magnetic storms.

These conclusions lead to reconsideration of the trans-Atlantic telephone cable as an auxiliary to short-wave systems. A single-channel cable would be of little value in supplementing a radio-telephone service of so many channels as there may be in the future. Moreover, the cable must also be capable of carrying a considerable group of telephone channels, and much progress has been made in that direction.

A multi-channel telephone cable to cross the ocean would have to be provided with intermediate repeaters on the ocean bottom, the repeater housing being incorporated within the cable structure. A small diameter housing incorporated as a part of the cable was therefore developed, the whole structure being so flexible that it could be bent around a cable drum.

The repeater housing comprised first a succession of pressure-resisting steel rings each having a diameter of about $1\frac{1}{2}$ in. and a width of $\frac{3}{4}$ in. Over these is slid a succession of thinner steel rings of the same width but overlapping the joints of the inner rings, the whole forming an articulated cylinder about 7 ft. long. An annealed copper tube with water-tight end seals is placed over this cylinder. Within the housing the repeater elements are separately contained in plastic cylinders about 6 in. long, loosely fitting inside the inner steel rings. Connexions between these units are made with flexible conductors. D.C. constant-current power must be fed to the repeater over the cable, and an operating potential of 2,000 volts to earth, oppositely poled at the ends of

the cable, was assumed. The repeater elements must rarely require attention and twenty years without replacement of parts was assumed to be reasonable. The problem of life and maintenance is principally one of a rugged long-lived vacuum tube. Ordinary vacuum tubes have limited service life on account of evaporation of material from thermionic cathodes. By making the level of transmitted signals relatively low, the space current may be kept very small and by making the cathode surface relatively large, this small current can be obtained at a temperature so low that the cathodes of the tubes may be expected to last for a very long time.

The number and spacing of repeaters depends on the length and design of the cable. For a cable 2,000 miles long to connect Newfoundland and Great Britain, forty-seven repeaters spaced 42 miles apart would provide for the transmission of a band 48,000 cycles wide.

The repeater is a one-way device and to provide two-way conversations two cables have been assumed, one directed eastward and the other westward. Assigning 4,000 cycles per channel, there would be room for twelve telephone circuits and as many as twenty-four fairly satisfactory 2,000-cycle channels could be provided.

As to the costs of such a cable for broad-band wire telephony to England via Newfoundland, even at somewhat higher annual charges than usual the total cost per telephone circuit for two cables with associated equipment would be comparable with that of prospective short-wave radio systems.

Short-wave radio links have a great advantage in affording direct connexion between points on the globe far apart, and the tendency has been to establish short-wave connexions directly between large centres rather than through extensive land-line links. The introduction of broad-band methods for transoceanic radio telephony will tend to favour centralizing radio traffic at a smaller number of more important terminals, but it is scarcely to be expected that all transoceanic radio traffic will thus be concentrated.

The world-wide transoceanic network of the future may well envisage a net comprising a large number of light linkages plus a small number of heavy linkages over the most important routes. The light linkages will represent direct short-wave single-channel or twin-channel connexions using relatively small power. The heavy linkages will comprise highly developed powerful broad-band short-wave radio systems making full use of frequency and directional diversity supplemented by broad-band submarine cables and in a few cases by long-wave radio as well.

One possible way to estimate the future for trans-Atlantic telephony is to compare the flow of telegraph traffic, say, between London and New York, with that between New York and San Francisco. Difference in community of interest is compensated to some degree by the difference in size of London and San Francisco.

This comparison may be made on the two bases of telegraph traffic, using the total number of words transmitted in a single year as the measure, and of the number of public service telegraph messages, excluding Press service, leased-wire service and code and cipher messages. In each case the estimate is based on terminating messages only. Data for the year 1937 are available and this particular year represents something between the 1929 peak and the trough of the succeeding depression.

On the first basis of comparison the total number of telegraph words transmitted over the two routes in 1937 was approximately the same. On the second basis the number of telegraph messages was about seven times as great between New York and London as between New York and San Francisco. The wide discrepancy between the two comparisons is doubtless accounted for partly by rates and partly by the character of business and social intercourse. Of the two, the second, which is based on plain-word public-service messages, appears more significant in relation to potential demand for telephone service, since public message telegraphy, as a somewhat closer approximation to the informal exchange of ideas by telephone, may be a better index of telephone demand. The potential demand for telephone connexion between New York and London is thus probably somewhere between one and seven times that between New York and San Francisco. Actually, in 1937 the telephone traffic between New York and San Francisco was about three times that between New York and London so that not more than a third, and possibly not more than a twentieth, of the potential telephone demand has been realized.

Assuming that the same ratio of potential to realized demand exists for all European–North American connexions as for the New York–London connexion, it may be estimated that 15–100 circuits will be needed across the North Atlantic depending on costs, but a demand for forty or more telephone circuits may justifiably be predicted in the reasonably near future.

To provide this increase in number of circuits, and to approach land-line standards of reliability and quality of service, all three systems—short-wave, long-wave and repeater cable—will need to be used. The bulk of the trans-Atlantic business will be handled on the short wave, but such an important service would have to maintain a higher standard of reliability than short-wave circuits alone can provide. A cable between America and Britain would provide this reliability, and it would set a high standard of transmission performance in competition with short waves.

It may not be necessary to wait until the growth of trans-Atlantic telephone business provides enough traffic to utilize fully a cable of the type described. When the engineers can give reasonable assurance of the cable it is believed that it will not have to await complete economic justification, because of the tremendous importance which it would have in ensuring privacy and continuity of trans-Atlantic telephone service.

There are already partly developed inventions which might greatly modify the picture of trans-oceanic telephony as set out above. One such is the 'vocoder', an instrument which dissects speech, transmits it in code and recreates it at the other end of the line. With vocoders a hundred or more simultaneous conversations might be carried by a pair of repeatered cables. While the vocoder would transmit the primary elements of conversation it would not provide all those qualities of speech which words alone do not convey. The vocoder gains in band width at the cost of naturalness of speech, but even so it may find important application.

Other inventions may extend the band-width available for transoceanic communication far beyond the range here discussed. Projects such as repeater ultra-short-wave radio systems and undersea wave-guides, which to-day appear fantastic, may some day come within the range of practicability.

THE RECORD OF PICTURESQUE BRITAIN

By DR. VAUGHAN CORNISH

THE second year's work of artists engaged in recording picturesque features of England and Wales is now on view at the National Gallery, London. This valuable work, initiated by a committee set up by the Ministry of Labour and National Service, has been made possible by a grant from the Pilgrim's Trust. It is intended that the drawings (which are the property of the Trustees) shall ultimately form a permanent collection.

A special feature of the present exhibition is a group of drawings of Windsor Castle by John Piper, lent by H.M. The Queen, who commissioned their execution after last year's exhibition. The rest of the present collection of drawings (about two hundred in number) includes examples from twenty counties, of which ten counties are additional to those comprised in last year's exhibition.

Of picturesque Buckinghamshire a charming corner house in Winslow and the red-brick town hall of Buckingham are faithfully depicted by Stanley Anderson, R.A. Notable examples of London and its environs are the Embankment, Pimlico, by Edward Walker, and The Admiral's House, Hampstead, by Norman James. Petersham and Ham in Surrey have been recorded in detail, both on account of the beauty of their seventeenth-century houses and the special risk of demolition owing to the nearness of London. Among these pictures are a general view of Ham Common, and the representation of two houses at Petersham with Dutch gable-ends facing the road.

Of towns in Hertfordshire, the steep street of Bishop's Stortford is shown in a charming pen-and-ink sketch by S. R. Badmin. The broad, open spaces of flat Suffolk are well shown in Martin Hardie's water-colour of Bawdsey Ferry.

On the western side of England, Ledbury in Herefordshire has been selected for its remarkable timber-frame houses; and, finally, crossing to Wales, Mona Moore's water-colour shows the low stone houses, of the fifteenth and sixteenth centuries, offset by a mountainous background.

In addition to buildings, the record of articles in use comes within the scope of the record of picturesque Britain. An interesting example is shown in Kenneth Rowntree's careful drawing of a coracle, the primitive boat which has come down from British times.

As this present World War goes on, we need to consider more carefully than hitherto the importance of the beauty of town and countryside in relation to the nation's welfare. When we look back to the early eighteenth century, we find the beauty of the countryside enhanced in both building and planting by the educated taste of the great landowners. Without attempting to consider the justification or otherwise of the taxation to which they are now subject, there is no doubt that if their mansions and parks be not preserved, the nation will lose one of its greatest assets of beauty. At the present time, it is of great importance to realize that an environment of beauty is no mere luxury but an essential condition for the happiness and spiritual welfare of the nation. If, however, such an environment is to confer its full benefit, the nation as a whole must be educated in the appreciation of scenery, both natural and architectural. Now that, in the twentieth century, education is no longer confined to the well-to-do classes, the proper understanding and full enjoyment of the æsthetics of scenery can be brought within the reach of all, if, but only if, the subject is brought properly before the attention of the whole community. Picture galleries are, of course, a help, but by no means sufficient. The most evident means at the command of the Government is a weekly broadcast allotted to the systematic teaching of the æsthetics of scenery.

COMMUNICATION PROGRESS

IN a lengthy article entitled "Milestones of Communication Progress" (*Elect. Comm.*, **20**, No. 3; 1942), H. T. Kohlhaas presents a comprehensive review of the developments in electrical communication which have occurred within the last twenty years. In the planning and co-ordinating of long-distance telephone communication, an outstanding event was the creation in 1924 of the International Consultative Committee on long-distance telephony in Europe, following a proposal made by Sir Frank Gill in his presidential address to the Institution of Electrical Engineers in 1922. Between 1923 and 1926 a succession of recorded steps led to the establishment of the first trans-Atlantic radiotelephony circuit between the United States and England. The first Madrid–Buenos Aires radiotelephone circuit was inaugurated in 1929 and it was followed in 1930 by the first radiotelephone circuit between the Americas. In 1931 the first demonstrations of single sideband short-wave radiotelephony were carried out between Buenos Aires and Madrid and between Madrid and Paris, establishing the now well-recognized improvements in transmission efficiency and the economies which this method makes possible.

In 1931 and the following years outstanding developments in the ultra-high frequencies were described. Long-distance telephone communication was established across the English Channel on approximately 1,600 mc. using very sharp beams. Work in this general field was continued with great activity and publications appeared on propagation of these very high frequencies in 1936 and 1937, the latter including a description of the first multi-channel ultra-short wave telephone link. Later, work on ultra-high frequencies was directed also to television transmission. On one hand, there were references in 1939 to the Eiffel Tower television station delivering 30 kw. to an exceptionally long feeder over the wide band of frequencies necessary for television, and on the other, to transmission over dielectric guides at frequencies from 1,000 mc. to 30,000 mc., using various types of positive grid triodes, klystrons, magnetrons or other tube structures.

High-power broadcasting on intermediate frequencies and high frequencies took a prominent place at this period. The Prague station with 120 kw. carrier was described in 1932 and was followed two years later by the Budapest station with the same carrier power. The latter was unique for its anti-fading mast antenna over 1,000 feet high, the highest antenna ever constructed. On higher frequencies, mention was made of two British Empire transmitters added in 1937 at Daventry, rated at 50 kw. carrier power at 22 mc. Early long-distance telephone communication to ships at sea was also recorded: on the *Berengaria* in 1929; the *Belgen-*

land in the winter of 1930–31 and the *Empress of Britain* in 1931–32. Successful conversations were held with London when a ship was in the China Sea and with New York when at Alexandria. Service to the *Majestic* was opened on February 14, 1930, at first for incoming calls only.

Important work on automatic direction finders was done in 1934 and onwards and an aeroplane automatic radio compass was described in 1936. This equipment was introduced in the United States in 1937, and important experiments were made and papers published on night error and mountain effects. The subject of ground direction finders avoiding polarization errors by the use of spaced vertical antennæ with high-frequency transmission line to distant receivers was studied around 1938 as was that of aerial navigation.

Less spectacular, but fundamental, were developments in automatic telephony and transmission in which field the application of machine switching to large areas, the rapid expansion of rural automatic networks and, in recent years, schemes involving complete national dialing in some of the smaller European countries, either on a timed and zoned metering basis or on an automatic ticketing basis, were outstanding examples. These national dialing schemes led to the development of a commercially practicable system for automatic toll ticketing, each ticket containing a complete record of each subscriber's telephone call. In 1937, 1939 and 1940 a series of articles appeared showing how automatic toll ticketing was developed and introduced commercially.

The wire transmission systems went through an evolution just as remarkable as that of automatic switching. References to the first carrier telephone systems in Brazil and Australia appeared in 1924 and 1925 respectively; the first loaded and repeatered long-distance French telephone cable, in 1927; and the first twelve-channel carrier systems and the first coaxial cable in England in 1937. Several lines of development, continued year after year, are only now yielding their reward in connexion with war efforts, and this is especially true of much of the work done on aerial navigation, on direction finding and in the general field of ultra-high frequencies. This 43-page review contains much of historical interest, and concludes with a list of 159 references to papers, etc., published during the period surveyed.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Tuesday, July 14

INSTITUTE OF PETROLEUM (JOINT MEETING WITH THE INSTITUTION OF CHEMICAL ENGINEERS AND THE CHEMICAL ENGINEERING GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY) (at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 5.30 p.m.—Dr. M. Ruhemann: "The Separation of Gases".

Wednesday, July 15

INSTITUTE OF CHEMISTRY (LONDON AND SOUTH EASTERN COUNTIES SECTION) (at 38 Russell Square, London, W.C.1), at 6 p.m.—Dr. J. Grant: "Chemist versus Forger".

Thursday, July 16

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (at Keppel Street, London, W.C.1), at 2.30 p.m.—Prof. Major Greenwood, F.R.S.: "Civilian Hazard of Life in this War and in the Last—a Profit and Loss Account for 1915–16 and 1940–41".*

Friday, July 17

PHYSICAL SOCIETY (OPTICAL GROUP) (in the Physics Department of the Imperial College, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. F. Twyman, F.R.S.: "The Interferometer in Lens and Prism Manufacture".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEADMASTER OF THE PORTSMOUTH GRAMMAR SCHOOL—The Chairman of the Governors, Paymaster Rear-Admiral G. Grant, 4 Old Cottages, Church Hill, Midhurst, Sussex (July 18).

TEACHER OF PHYSICS, MATHEMATICS AND ENGINEERING SCIENCE, and a TEACHER OF WORKSHOP PRACTICE, in the Doncaster Technical College—The Chief Education Officer, Education Offices, Doncaster (July 21).

VETERINARY INVESTIGATION OFFICER—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (July 30).

TWO DEMONSTRATORS (MALE OR FEMALE) IN ANATOMY—The Registrar, The University, Sheffield (July 31).

LECTURER IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College, Southampton (August 4).

TEACHER FOR DAY AND EVENING ENGINEERING CLASSES, and a TEACHER FOR ENGINEERING WORKSHOP PRACTICE AND METALWORK—The Principal, County Technical College, Gainsborough.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Memoirs of the Cotton Research Station, Trinidad. Series A: Genetics, No. 18: Anthocyanin Pattern in Asiatic Cottons. By R. A. Silow and C. P. Yu. Pp. 249–284. (London: Empire Cotton Growing Corporation.) 2*s*. 6*d*. [226

Royal Meteorological Society. Bibliography of Meteorological Literature. Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office. Vol. 5, No. 2, July–December 1941. Pp. 13–30. (London: Royal Meteorological Society.) 2*s*. 6*d*. [256

Hertfordshire County Council. The School Child and the School Canteen. An Inquiry undertaken by F. LeGros Clark and presented to the Education Committee. Pp. 36. (Hertford: County Hall.) [256

Annual Reports on the Progress of Chemistry for 1941. Vol. 38. Pp. xxxii+326. (London: Chemical Society.) 15*s*. [256

Geological Survey of Great Britain: Scotland. Wartime Pamphlet No. 27: The Oil-Shales of the Lothians—Structure. Area 1: West Calder. By Dr. J. E. Richey; with Appendix by W. Manson and Contributions by W. E. Graham. Pp. 42. (London: Geological Survey and Museum.) 1*s*. 10*d*. [17

Other Countries

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 6 (Monograph No. 5): Pupil Personnel Services as a Function of State Departments of Education. By David Segel and Maris M. Proffitt. (Studies of State Departments of Education.) Pp. vi+84. 15 cents. Bulletin 1941, No. 7: School Library Administration as Annotated Bibliography. Prepared by Nora E. Beust. Pp. vi+82. 15 cents. (Washington, D.C.: Government Printing Office.) [226

University of Illinois: Engineering Experiment Station. Bulletin Series No. 334: The Effect of Range of Stress on the Fatigue Strength of Metals. By James O. Smith. Pp. 49. 55 cents. Reprint Series No. 22: Eighth Progress Report of the Joint Investigation of Fissures in Railroad Rails conducted by the Engineering Experiment Station, University of Illinois, in co-operation with the Association of American Railroads and the Rail Manufacturers Technical Committee. By Herbert F. Moore. Pp. 38. 15 cents. (Urbana, Ill.: University of Illinois.) [226

Proceedings of the United States National Museum. Vol. 92, No. 3139: The Chrysomelid Beetles *Luperodes bivattatus* (LeConte) and *Varicornis* (LeConte) and some Allied Species. By Doris H. Blake. Pp. 57–74+plates 5–6. Vol. 92, No. 3140: Notes on the Classification of the Staphylinid Beetles of the Groups Lispini and Osoriinæ. By Richard E. Blackwelder. Pp. 75–90. (Washington, D.C.: Government Printing Office.) [226

U.S. Department of Agriculture. Farmers' Bulletin No. 1886: The Beet Leafhopper. By W. C. Cook. Pp. ii+21. (Washington, D.C.: Government Printing Office.) 10 cents. [236

University of California Publications in Zoology. Vol. 46, No. 1: The White-crowned Sparrows (*Zonotrichia leucophrys*) of the Pacific Seaboard; Environment and Annual Cycle. By Barbara D. Blanchard. Pp. iii+178 (20 plates). (Berkeley and Los Angeles, Calif.: University of California Press; London: Cambridge University Press.) 2 dollars. [256

Forest Bulletin No. 106 (Silviculture Series): The Control of Lantana by a Sodium Chlorate Spray. By A. L. Griffith. Pp. vi+8+2 plates. (Delhi: Manager of Publications.) 6 annas; 7*d*. [17

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 37: Milk Records of Cattle in Approved Dairy Farms in India. Vol. 2 (Records received during 1937–38), Part 2: Buffaloes. Compiled by the Animal Husbandry Bureau, Imperial Council of Agricultural Research. Pp. vi+325–614. (Delhi: Manager of Publications.) 5 rupees; 8*s*. [17

Catalogues

Electric Furnaces. (Publication 51.) Pp. 4. (London: Johnson, Matthey and Co., Ltd.)

Glo-Pass Security System. Pp. 12. (London: Colloidal Research Laboratories, Ltd.)

Chance-Parsons Optical Glass. (CP.400.) Pp. 22. (Smethwick: Chance Brothers and Co., Ltd.)